THE WOODPECKER PROJECT

A PRELIMINARY REPORT

Prepared for the
1987 World Administrative Radio Conference
on the High Frequency Broadcasting Service
International Telecommunication Union
Geneva, Switzerland

SUMMARY

This report describes recent patterns of spectrum occupancy and interference caused to international broadcasts by the powerful pulse emissions known colloquially as the "Woodpecker." Heard worldwide since 1976, these signals step erratically through the High Frequency (HF) band 24 hours a day.

The evidence herein, based largely on a coordinated monitoring effort by shortwave listeners in 19 countries during October 1985, shows that Woodpecker interference is a significant and widespread problem for international broadcasters and their audiences. One hundred and forty-two reports of interference to stations in the HF Broadcasting Service were received between June and November 1985. When screened against station schedule information, 99 reports of interference to 35 stations were validated. The number of interference incidents reported was greatest for Radio Australia (17), the British Broadcasting Corporation (12), Voice of America (9), Radio Japan (8), Radio Moscow (7), Radio Beijing (6), Radio Tirana (5) and Radio Nederland Wereldomroep (4).

As sponsor of this monitoring project, the Association of North American Radio Clubs believes that the 1987 World Administrative Radio Conference for the HF Broadcasting Service is the appropriate forum to consider and endeavor to resolve the problem of "Woodpecker" interference. As a step toward this end, we recommend that Delegations attending the Conference adopt the following statement (or one like it) as part of the Conference's Final Protocol:

> "High-powered pulse transmissions within the HF Broadcasting Service bands are incompatible with the rational utilization of those bands by stations in the Broadcasting Service. Elimination of these emissions is essential to the development and implementation of effective plans for the HF broadcasting bands."

The Woodpecker Project
Association of North American Radio Clubs
1634 15th St. NW
Washington, DC 20009 USA

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The Woodpecker Project: A Preliminary Report

by
Robert Horvitz
(project coordinator)

The Woodpecker Project is a global monitoring and research effort organized by the Association of North American Radio Clubs (ANARC).[1] Initiated in 1985, the Woodpecker Project is not affiliated with or sponsored by any national Administration or government agency; it is staffed entirely by unpaid volunteers.

The purpose of the Woodpecker Project is to gather, analyze and disseminate information concerning a type of pulse emission found in the High Frequency (HF) radio band. Nicknamed the "Woodpecker" because of the sound the pulses make when heard on communications receivers, these signals are audible in most parts of the world. They often cause severe interference to international broadcasts, aeronautical and maritime communications, Amateur radio operators, and stations in the HF Fixed Service. Concern for the deleterious effects of this interference on HF communications services - especially international broadcasting - is the motivating force behind the Woodpecker Project.

Historical Background

The earliest known report of Woodpecker interference was a complaint filed with the US Federal Communications Commission (FCC) concerning the

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[1] Founded in 1964, ANARC is a consortium of radio hobby groups based in North America. The total combined membership of the eighteen ANARC-affiliated clubs is currently about 10,000, the majority of whom are active shortwave listeners.

14000-14200 kHz band at 0300 UTC on 12 July 1976.[2] Many other complaints soon followed, from amateur radio operators, international broadcasters, and maritime and aeronautical stations.

Identifying the Source. A number of member Administrations of the International Telecommunication Union (ITU) forwarded complaints to the ITU's International Frequency Registration Board (IFRB). On 17 September 1976, the IFRB sent letters to the Administrations of Austria, Belgium, the Federal Republic of Germany, France, Norway and Sweden, asking them to implement a monitoring program in order to identify the source of the interference. Apparently as a result of this monitoring program, on 25 October 1976 the IFRB sent a telex to the Soviet Union asking it to "take the necessary measures to eliminate the interference."[3]

On 12 November 1976, the head of the International and Operations Division of the FCC advised the US State Department of the FCC's findings as to the source of the interference:

> "After thirty-seven separate direction-finding alerts, the station's fix has averaged out to be 51 [degrees] North by 31 [degrees] East, the vicinity of Kiev. Information received from the British Broadcasting Corporation indicates the station is located at Gomel. Communication with Radio-Suisse Ltd. indicates the Soviet station is located in the Kiev-Gomel area."[4]

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[2] Records of this and hundreds of other complaints filed with the FCC were obtained by ANARC under a Freedom of Information Act request in 1983.

[3] See Appendix, below: "Annex to the I.F.R.B. Report on Harmful Interference in the High Frequency Bands Caused by Emissions Originating in the U.S.S.R.," International Telecommunication Union, Geneva, 10 November 1977, page 6.

[4] Letter from Robert L. Cutts, Chief, International and Operations Division, FCC, to Gordon Huffcutt, Office of International Telecommunications Policy, US Department of State, 12 November 1976.

The Soviet Union's Response. Responding to the numerous complaints it had received, on 3 December 1976, the Administration of the USSR sent this telex to the IFRB:

> "In the Soviet Union tests are being carried out with radio installations operating in the HF bands. These tests may cause interference to radio installations for short periods. The necessary measures are being taken to reduce any such interference. The reports which you have sent us will be carefully studied."[5]

However, the interference persisted. Additional complaints were filed by Denmark, the Federal Republic of Germany, France, Norway, the United Kingdom and the United States. On 10 May 1977, the IFRB sent a letter to the Soviet Administration inquiring about "the measures being taken to eliminate the interference."[6] The USSR responded on 5 July 1977 that

> "...in the Soviet Union the investigation of HF radio stations is continuing. Steps are being taken to eliminate possible interference with the radio services of other [countries]... The effectiveness of the measures adopted is confirmed by data collected by the monitoring services. Further action aimed at the prevention of interference is scheduled."[7]

IFRB Report. More complaints were lodged with the IFRB as the interference continued unabated. This led to the issuance of an "I.F.R.B. Report on Harmful Interference in the High Frequency Bands Caused by Emissions Originating in the U.S.S.R.," on 10 November 1977, a copy of which is appended to this report. As the document notes,

> "This case of interference is exceptional insofar as the wide-band emissions...are reported at various frequencies over an extremely

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[5] "Annex to the I.F.R.B. Report...," loc. cit.

[6] Ibid., page 7

[7] Ibid.

> wide range of the high frequency spectrum and no notifications have been made to the I.F.R.B...
>
> "The finding of the Board is that the station or stations in question should cease operation until such steps have been taken to ensure that any interference that may result from the resumption of such tests shall be below the level that would be considered as harmful interference."[8]

WARC Statements. But the "station or stations in question" did not "cease operation." So at the 1978 World Administrative Radio Conference (WARC) for Aeronautical Mobile (R) Services, the Delegations of Denmark, the Federal Republic of Germany, Greece, Norway, Sweden and Switzerland contributed this joint statement to the Conference's Final Protocol:

> "...Commencing in 1976, very powerful pulse transmissions from HF stations operating within the territory of the USSR have been causing continued harmful interference over large areas on frequencies in the HF bands, including those allocated to the Aeronautical Mobile (R) Service, and will, if not terminated, be liable to cause harmful interference on frequencies in the new plan.
>
> "The above Delegations refer to Article 35 in the Convention, and to Resolution No. AER-2 of the Radio Regulations, and express their great concern about this prolonged violation of the said provisions. Their Administrations reserve the right to take appropriate measures to protect the Aeronautical Mobile (R) Service, and other radio services, if this harmful interference continues."[9]

The Soviet Delegation responded to this statement in Conference Document No. 330-E, also included in the Conference's Final Protocol:

> "...In the Soviet Union the research on radio-wave propagation... might perhaps (according to the statements of Administrations of certain States) cause some short-term interference to individual services. Similar signals have been recorded in the Soviet Union by the receiving apparatus and monitoring service from the operation of installations of other countries.

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[8] Ibid., page 5.

[9] Statement No. 45, Final Protocol, Final Acts of the World Administrative Radio Conference on the Aeronautical Mobile (R) Service, ITU, Geneva, 1978.

> "With a view to reduce possible interference to the Aeronautical and Maritime Mobile Services...from the above-mentioned research operation, conducted in the Soviet Union, a number of technical and organizational measures have been taken.
>
> "At present radio monitoring services confirm the efficiency of measures taken.
>
> "In carrying out these studies, the Administration of the Soviet Union takes due account of the provisions of the International Telecommunication Convention and the Radio Regulations."

No details or evidence were provided as to the existence of "similar signals" emanating from "other countries." So far as we are aware, the Woodpeckers are unique in the type and extent of the interference they cause.

The issue of Woodpecker interference has apparently not been discussed at any WARC since 1978, nor have the Final Acts or Final Protocols of any WARC since the Aeronautical Mobile (R) Conference expressed the views of any Administration on the persistence of the interference.

Additional Woodpeckers. Signals from a second Woodpecker-type transmitter, with "emission and mode of operation...identical" to the station near Kiev, were detected by the FCC starting on 10 April 1979. Initial bearing measurements placed the new source near the Pacific Coast of Siberia, in the general vicinity of Sakhalin Island and Khabarovsk.[10]

The appearance of a third transmitter site was reported by the

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[10] Letter from Robert L. Cutts, Chief, International and Operations Division, FCC, to Gordon L. Huffcutt, Office of International Communications Policy, US Department of State, 18 April 1979.

Associated Press on 15 May 1980.[11] We suspect this station is located just north of the Black Sea, near Nikolayev.[12]

Signal Characteristics

The Woodpeckers seem to be able to transmit on any frequency between about 5 and 28 MHz. The duration of each pulse is approximately 3 milliseconds (ms), and the pulse repetition rate is nearly always 10 per second.

Signal Strength. Fluctuations in received signal strength are common. This may be due to the vagaries of ionospheric propagation; changes in beam heading, elevation, or radiation pattern; changes in transmitter power output or the antenna utilized; or some combination of these or other factors. Despite the fluctuations, when propagation is strong and a Woodpecker station is operating at full power, its signals can be the loudest sound in the entire HF band, even in regions far from the USSR.

At the top of the next page is a photograph of the display of a spectrum analyzer, taken around 1900 UTC on 14 October 1985. The Woodpecker is the

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[11] Norman Black, "Russian Woodpecker," Associated Press Wire Service, 15 May 1980.

[12] Since the Woodpecker stations are not formally registered with the IFRB, and since the Administration of the USSR has not indicated where in the Soviet Union they are located, all information we have concerning their locations comes from secondary sources, propagation studies based on monitoring, and an hypothesis concerning the purpose of the transmissions. For the first two Woodpecker sites, bearing measurements made by the FCC appear to correlate with the locations of over-the-horizon (OTH) radar installations shown on maps in the US Defense Department's annual public report on Soviet Military Power. Further evidence supporting the hypothesis that the Woodpeckers are OTH radars comes from analysis of their signal characteristics and operational patterns. Thus, absent bearing measurements by the FCC for the third Woodpecker site, we ascribe it to the location of the third Soviet OTH radar shown on the Defense Department maps - that is, near Nikolayev.

multi-peaked silhouette in the center. The filled-in white peaks in the right half of the screen are international broadcasting stations around 11700 kHz. The fact that the Woodpecker signal is superimposed on one of the broadcasting signals indicates that it is interfering with that broadcast, and the fact that its height is greater than the broadcasting signal's indicates that its signal strength is superior.[13]

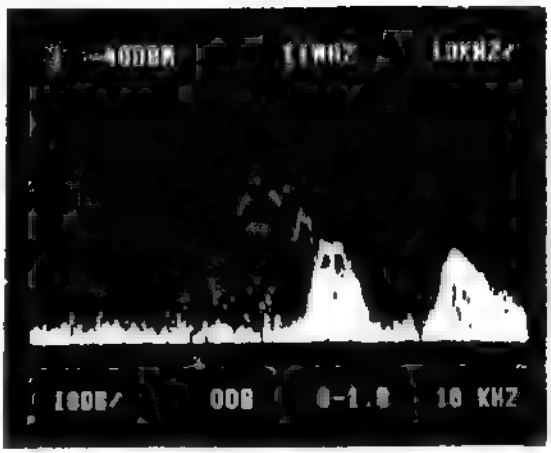

Figure 1

Internal Structure. The spectrum analyzer also reveals the complexity of the Woodpecker pulse's internal structure. The photograph at right shows three pulses, two of them overlapped in the left half of the screen, another

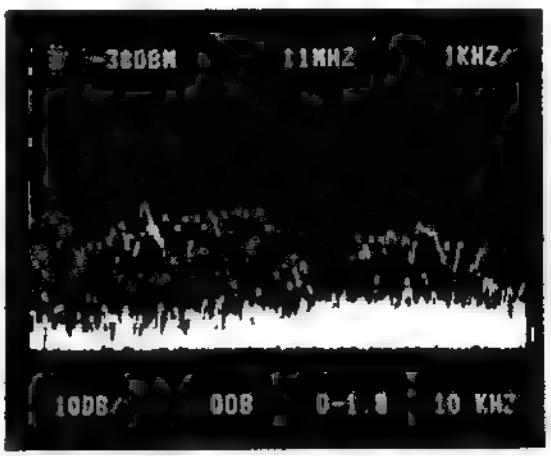

Figure 2

[13] The Tektronix Corporation lent the Woodpecker Project a Model 492P digital storage spectrum analyzer for the month of October 1985. Fed by a simple 15-foot vertical long-wire antenna, the spectrum analyzer enabled us to detect and observe Woodpecker signals anywhere in the HF band, whenever they propagated to Washington, DC. Photography was done with a fixed-focus Polaroid camera, with hood mount, and Type 108 film. The brevity of the pulse duration, the pulse repetition rate, and the ASA rating of the photofilm, combined to make photographing a single pulse a challenge. Unfortunately, the spectrum analyzer control settings needed to accomplish this were different from the settings required to make accurate measurements of the pulse amplitude, bandwidth and center frequency. In this image, the apparent bandwidth of the pulse is significantly reduced by the 1 ms/div. sweep-rate setting.

in the right half of the screen.[14] The rapid (~100 microsecond) amplitude fluctuations visible within the pulses may be due to phase modulation, with each down-spike representing a phase reversal. As received in the United States, the internal structure of the pulses seems to vary continually. Observers in the United Kingdom report it as relatively stable.[15] This difference could be due to the additional ionospheric refractions needed to deliver the signals to North America, which compound the garbling effect of multipath propagation.

Whatever its cause or purpose, the modulation carried by the pulses greatly increases their aural "opacity": it masks the information content of co-channel signals more effectively than an unmodulated pulse of the same power, duration and repetition rate, making the interference more destructive.

Bandwidth. According to the 1977 IFRB report, "the basic emission lies within a bandwidth of some 16-18 kHz (containing 70-80% of the total power) accompanied by a large number of sidebands spaced symmetrically at 10 kHz intervals on each side."[16] This is illustrated in the diagram at the top of the next page, sent to the FCC in an interference complaint by an Amateur radio operator in 1979 [17]:

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[14] An increase in spectral resolution in Figure 2 accounts for the greater dilation of the pulses than in Figure 1.

[15] See J. P. Martinez (letter), Wireless World, April 1982, p. 59; and F. C. Judd, "Over-the-Horizon Radar Systems - Beyond the Blue Horizon (Part 2)," Practical Wireless, September 1983, pp. 44-47.

[16] Op.cit., page 3.

[17] James C. Shaw, W6JQX, based on monitoring at 0636-0659 UTC on 13 November 1979.

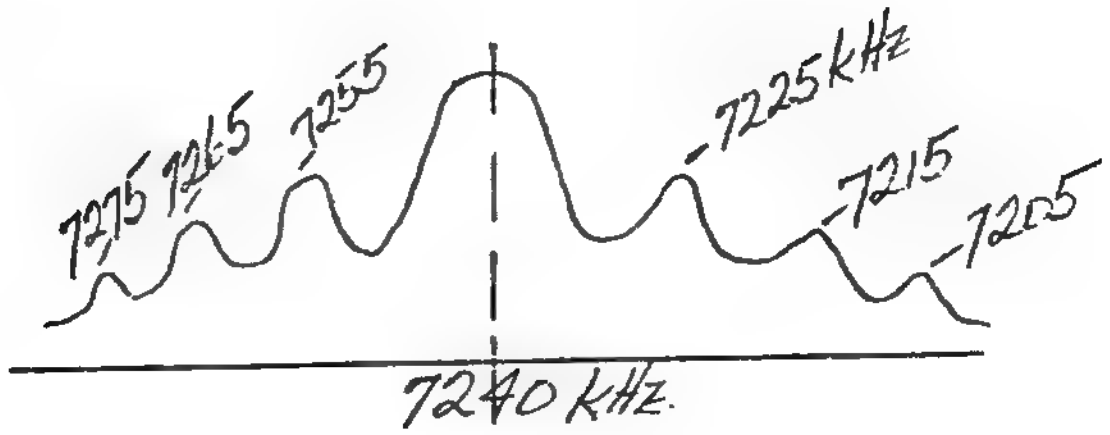

Figure 3.

When propagation is weak, the sidebands of the pulse may be inaudible. When propagation is strong, the sidebands can be powerful enough to overwhelm communications signals 20-30 kHz from the center of the pulse bandwidth.

The average bandwidth of the Woodpecker signals logged by FCC monitoring stations prior to 31 January 1977 - when only one transmitter site was known to be active - was nearly 300 kHz.[18] An FCC study in 1983 found that bandwidth "measurements varied with propagation conditions from a minimum of 20 kHz up to 700 kHz."[19] On 4-5 August 1985, the apparent bandwidths of forty-one Woodpecker dwells were measured during a 2-hour tracking exercise in Washington, DC, while the signal was in the 16-17 MHz band.[20] On this

[18] Based on fifty-seven observations recorded in FCC documents obtained through our Freedom of Information Act request. This extraordinary bandwidth may have been achieved by use of multiple pulse-trains (see below).

[19] David J. Smith, "Study of the Russian Woodpecker Signal," FCC Memorandum, 8 June 1983, p. 2.

[20] This exercise was an attempt to see how effective high-grade communications receivers could be in tracking Woodpecker signals. Because their passband filters are much narrower than the signals of interest, and several pulse-trains are often on the air simultaneously, communications receivers are far from ideal for such tracking. The exercise was performed

occasion, the audible bandwidths varied from 5 to 67 kHz (weaker signals seeming narrower, stronger ones wider) and averaged about 26 kHz.

Multiple Pulse-trains. Each Woodpecker site apparently can transmit up to four synchronized pulse-trains simultaneously. These can be sent out on the same frequency, on different frequencies, or aggregated to cover wider bandwidths. With three sites on the air simultaneously, each emitting several pulse-trains, a significant fraction of the HF band can thus be affected.

Dwells and Shifts. The FCC noted in 1977 that the Woodpecker sometimes swept continuously across a band. This has not been observed in recent years. Instead, the signal "dwells" for a period of time in a static range of frequencies until it abruptly shifts to another range, where it stays until shifting again. This pattern is shown in the tracking chart on the next page (Figure 4). Visual monitoring with a spectrum analyzer

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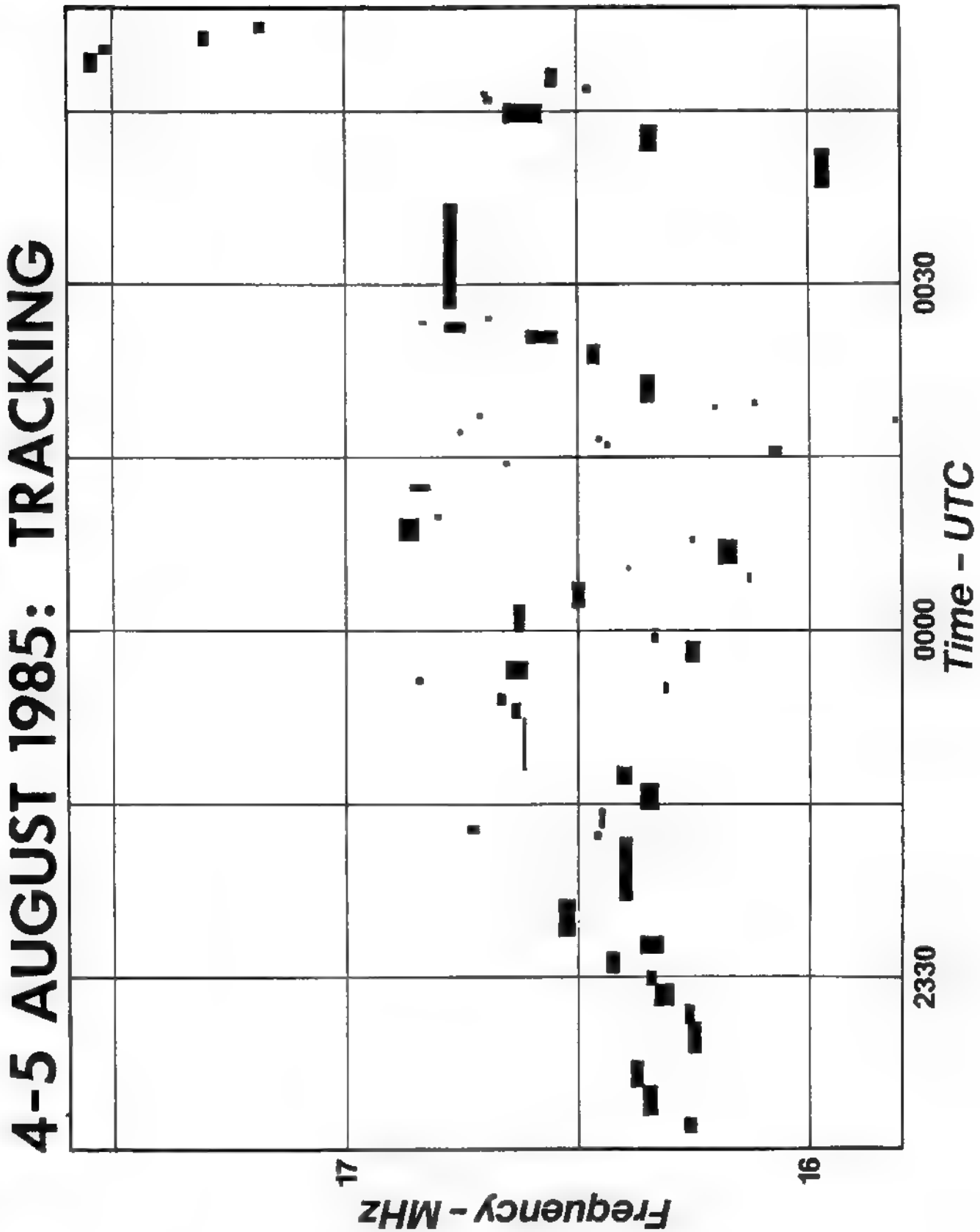
by a monitor using a Drake R7, fed by a 30 foot horizontal long-wire antenna mounted on an east-west axis some 40 feet above ground-level, and an Icom IC-R71A, fed by a 30 foot horizontal long-wire mounted on a north-south axis 40 feet above the ground. The receivers were positioned side by side just below eye-level, above a desk for the logsheets and digital stopwatch. The Icom has switchable dual tuning circuits (VFOs), so the two receivers approximated the performance of three tuners.

When a Woodpecker signal was found, the time of acquisition was noted, along with the limits of the frequency range in which the signal was audible, and the frequency where it was loudest. Meanwhile, the other receiver was used to search for additional pulse-trains. When the Woodpecker changed frequencies, its time of departure was recorded, and the two receivers were rapidly and simultaneously retuned to search for it. It was usually found within a few seconds. When it was not found quickly, the tuning search widened to about 2.5 MHz above and below the last-heard frequency. This technique was practiced and refined for several hours prior to the monitoring on 4-5 August. The exercise continued until the Woodpecker left the 15-18 MHz band at 0052:44 UTC. Bandwidth measurements cited here were all made on the Drake using a 2.3 kHz passband filter. The frequency distribution observed during the tracking is shown in Figure 4 (next page).

Figure 4


4-5 AUGUST 1985: TRACKING
Frequency - MHz
17
16
Time - UTC
2330
0000
0030

confirms that the signal is capable of shifting from one frequency to another without appearing on intermediate frequencies and without missing a beat.

The dwell times observed in the FCC's 1983 Woodpecker study "varied from a few minutes to an hour with the average duration of about 15 minutes."[21] During our tracking exercise, they varied from a few seconds to just under 9 minutes, and averaged about 1'36". However, much longer dwell-times are regularly observed. One of our monitors in Canada reported one on 1 October 1985 that lasted some 2 hours and 20 minutes, centered on 13785 kHz.[22]

Dwell Duration and Bandwidth of Operation. We have at times noticed something like an inverse relationship between dwell time and the overall frequency range of Woodpecker operations. This relationship is not a rigid one, but it can be glimpsed in the tracking chart on the previous page (Figure 4): from 2315 to 2345 UTC, for instance, the signals ranged between 16230 and 16727 kHz (that is, stayed within a 497 kHz range), while the average dwell time was about 2'23". From 2345 to the beginning of the long dwell at 0028, the signals remained between 15810 and 16885 kHz (a 1075 kHz range), and the average dwell time was about 33".

A generalization of this relationship might be: when the signals are scattered over a relatively wide range of frequencies, individual dwells tend to be of short duration; when they are in a narrower range, dwells tend

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[21] Smith, loc. cit.

[22] Because this dwell was observed during the coordinated monitoring exercise described below, it may have been interrupted while the monitor was scanning elsewhere in his assigned band.

to be longer. This rule reduces to the truism that during each dwell, the band of operation is the bandwidth of the signal - unless, of course, there is more than one pulse-train. The number of pulse-trains transmitted simultaneously may be related to the overall bandwidth of operation.

On the other hand, since the Woodpeckers seem to be able to step anywhere from 5 to 28 MHz at any moment, and operate simultaneously in widely separated bands, the bandwidth/duration relationship implied in some of our data is probably not due to mechanical constraints imposed by the system hardware. It may derive from the purpose or function of the emissions.

The 1983 FCC report speculated that "the seemingly random frequency changes could be the result of computer control and propagation data being fed from a sounder."[23] In our view this is a reasonable explanation, although further study is needed to establish more specifically how frequencies and bandwidths are selected.[24] A greater understanding of this process may yield suggestions for ways to reduce harmful interference to other users of the HF band without adversely affecting the research which is supposedly the reason for the transmissions.

Irregularity. One of the most striking characteristics of Woodpecker signals is the irregularity of their movements about the spectrum (cf. Figure 4). A review of our logs covering many hours of monitoring reveals no

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[23] Smith, loc. cit.

[24] Speculation on this question should be unnecessary. If the Woodpeckers are in fact for "research on radio-wave propagation," a description of the way frequencies are selected would be a logical part of an exposition of the findings of this research.

regular increments underlying the observed dwell times or frequency shifts.[25]

However, on rare occasions we have observed the Woodpecker switch to a less familiar mode (e.g., change pulse rate or adopt a different waveform) for limited periods of time. During these periods, lasting at most a few hours, regular patterns and cyclical behavior have been noted.[26]

Unpredictability. Perhaps related to the irregularity is the Woodpeckers' unpredictability. Although we lack knowledge of how frequencies are selected, if real-time sounding of the environment is the basis of the process, as the FCC has suggested, then neither perfect knowledge of the procedures, nor exact records of the Woodpeckers' behavior over an extended period of time, would be sufficient to predict precisely what channels will be affected in the next five minutes.

While the moment-to-moment behavior is irregular and seemingly unpredictable, over longer time spans, some regularities in band use are evident. For that reason, the Woodpecker Project decided to organize a

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[25] Observation of Woodpecker signals on an oscilloscope reveals that several milliseconds are added or subtracted from the interval between pulses once every 6 seconds. The reason for this is not clear, but it seems to have nothing to do with the timing of dwells or frequency changes.

[26] For example, at 0115-0215 UTC on 16 August 1984, a Woodpecker transmission was observed switching to an unmodulated pulse for 45 seconds, then to pulsed FM for 45 seconds, back to the usual modulated pulse for 15 minutes, then the other waveforms again for 45 seconds each. The usual 10/second pulse rate was maintained, initially on 8180, then on 8002 kHz. Episodes such as this suggest a test or experiment distinct from the normal mission. See G. N. Trachev, "Depth of Polarization Fading of Signal Power Scattered on Thermal Fluctuations of Ionospheric Electrons," Radiotekhnika i Elektronika, Vol. 27, No. 7 (1982) [translated from Russian in JPRS 82950, US Joint Publications Research Service], for description of a similar signal test format.

global-scale coordinated monitoring effort to learn what we could about the Woodpeckers' habits and recent band use, and gather empirical data about the geographical distribution of the interference.

Scheduled Monitoring - October 1985

Noting that the Second Session of the World Administrative Radio Conference for HF Broadcasting was to take place early in 1987, and believing that this Conference would be the appropriate forum for discussing the issue of harmful interference caused to HF broadcasting stations and their audiences by Woodpecker transmissions, October 1985 was designated as a month for intensive information-gathering by the Woodpecker Project.

Purpose. Establishing the general patterns of band use and gathering specific reports of Woodpecker interference caused to international broadcasts were our two main goals. We also wanted to make greater use of monitors located in other countries to highlight the widespread nature of the problem. Because the program of scheduled monitoring and the gathering of interference reports were distinct, though complementary, activities, they will be discussed here separately.

Choice of Month. No special significance should be attached to October insofar as the Woodpeckers' activity is concerned. This month was chosen largely because it seemed to allow adequate time for pre-publicity and analysis of the results. Monitoring on a spot-check basis in August, September, November and December 1985 indicates that October was fairly typical of the Woodpeckers' band use in the second half of 1985 (taking into

account seasonal factors, including the progression of local sunrise and sunset times, with attendant changes in propagation to various regions).

However, in comments filed with the reports from our monitoring exercise, many participants remarked that Woodpecker interference seemed to be at a lower level in October than earlier in the year, and at a much lower level than in previous years (see especially the results from Europe, below). While we believe that October fairly represents Woodpecker activity in the second half of 1985, questions remain as to how typical that larger time period was. We suspect that our findings probably understate the level the interference that has characterized Woodpecker operations over the past ten years.

Ionospheric Conditions. Two sources were consulted at the time of the monitoring with regard to current ionospheric conditions. IPS Space Services of Sydney, Australia, in their weekly report broadcast on Radio Netherlands World Service (recorded 2 October 1985), said that during the previous week there had been no visible sunspots; the solar flux was low; the ionosphere was weak, depressed to 50% of normal levels; and the geomagnetic field was disturbed. They predicted that the geomagnetic field would continue to be disturbed, due to coronal holes, and might be especially disturbed on 13-14 October.

The US National Bureau of Standards' Solar-Terrestrial Report, broadcast on station WWV at 0018 UTC on 4 October, said that the solar flux was 69; the A index was 16; the K index was 2; solar activity during the past 24 hours was very low and would be very low during the next 24 hours; the

geomagnetic field in the past 24 hours was at minor storm levels to active, and in the next 24 hours would be active to unsettled.

The Solar-Terrestrial Report at 2018 UTC on 13 October said that the solar flux was 67; solar activity during the past 24 hours was low and would continue low in the next 24 hours; geomagnetic activity in the past 24 hours had been at minor storm levels to active, and was forecast to continue active.

The eleven-year cycle of solar activity was approaching its cyclical low at the end of 1985. As any shortwave listener can attest, reception conditions were among the worst in a decade. It is likely that the Woodpeckers' operations were also affected, but without knowing more about their mission, it is hard to assess what the effect might have been. Solar and ionospheric conditions may well have affected the overall pattern of band use; in particular, they probably limited the use of higher frequencies (over 20 MHz).

Scheduling the Volunteers. Beginning in May 1985, through announcements in radio publications and on broadcasts of popular "DX" programs, shortwave listeners around the world were invited to sign up for a coordinated monitoring exercise scheduled for October 1985.[27] Those who volunteered were asked to rank according to their preference one or more 3-hour time periods on 1, 4, 7, 10 or 13 October (UTC), during which they would be responsible for scanning a band 3 MHz wide at least once every 10

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[27] Among the international broadcasting stations that aided our call for volunteers were the British Broadcasting Corporation, ORF (Austria), Radio Canada International, Radio Nederland Wereldomroep, Radio RSA (South Africa), Radio Sweden International, Spanish Foreign Radio, the Voice of America and WRNO (US).

minutes. The project description sent in response to all inquiries, as well as the sign-up form, are reproduced on the next two pages (Figures 5 and 6).

One hundred and seventeen shortwave listeners returned the sign-up forms, in most cases expressing preferences for several time-slots (shifts). We reviewed the volunteers' preferences and assigned them to shifts on a first come, first served basis, starting with 1 October, then 13 October, then 4 October, then 10 October, then 7 October. Since each monitor was to scan 3 MHz during one or more 3-hour shifts, and we wished to cover 5-23 MHz [28], monitors were assigned to one of six bands (5-8, 8-11,...20-23 MHz) during one or more of the eight shifts (0000-0300, 0300-0600,...2100-2400 UTC). Our overall schedule thus consisted of 6 bands x 8 shifts or 48 band-shifts per day.

We tried to maximize the geographical diversity represented in each band-shift, while limiting the number of monitors in each band-shift to three. Following this method, we filled 86 reporting slots on 1 October, 40 on 4 October, and 100 on 13 October.[29] However, the number of volunteers for 7 and 10 October was insufficient to cover the available band-shifts, so these days were dropped from our schedule.

In addition to those scheduled for specific band-shifts, four people in the Washington, DC, area agreed to be available as last-minute replacements

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[28] This corresponds to the previously-reported operating range of the "Woodpeckers," minus the 23-28 MHz band, which we expected to be relatively inactive during the monitoring period because of low sunspot activity.

[29] Because our coverage of 4 October was skimpy, monitors were not assigned to bands where propagation from the suspected Woodpecker sites to their locale was physically unlikely. We viewed monitoring on this day as supplementary to the findings of the two more fully scheduled days.

The Woodpecker Project

Coordinated by the
Association of North American Radio Clubs'
Over-the-Horizon Radar Committee
1634 - 15th St. NW
Washington, DC 20009
U S A

Purpose: To gather current data on the worldwide interference caused to shortwave broadcasters and their audiences by the high-power pulse emission sources known colloquially as the "Woodpeckers". This data will be analyzed and presented to telecommunications ministries of countries participating in the 1987 World Administrative Radio Conference for High-Frequency Broadcasting, in an effort to convince them to support a protocol statement condemning this interference.

Data needed: 1) In order to map the "Woodpeckers'" general band use, we need large numbers of volunteers to monitor parts of the spectrum between 5 and 23 MHz for 3-hour periods during October 1985. If each monitor covers 3 MHz, and at least 3 geographically-separated monitors are scheduled for each time- and band-segment, then at least 144 monitors are needed for 24-hour coverage. We would like to gather 5 days worth of data. That requires at least 720 volunteers. Attached to this sheet is a sign-up form. Please fill it out, indicating what times you can commit to monitoring. Return it without delay - in any event, before 15 August 1985. We especially need people able to monitor at unusual times (just before local dawn, for example). A sample of our monitoring report form is attached to this sheet. It is a simple graphic system requiring minimal effort to complete.

2) We also seek reports of specific instances of "Woodpecker" interference to stations operating in the shortwave broadcast bands. Reports should include the name of the affected station, its frequency, the date and time, duration and relative strength of the interference, the type of receiver, and your location. A sample report form is attached to this sheet. Reports not using this form are acceptable, too, so long as they contain the same information. Mail us your reports before 1 November 1985.

Recognizing "Woodpecker" signals: They're called "Woodpeckers" because that's what they sound like on a shortwave radio. Technically, the signal is a 3 millisecond square-wave pulse with a stable pulse-rate of 10/second. (Rates of 17 and 7.4/sec have also been heard, but rarely.) The signal is wide-band, with most of the energy concentrated in about 15 kHz, and a weaker "pulse-scape" filling the adjacent spectrum. The energy concentrations can be clustered together to cover 100 kHz or more. The "Woodpeckers" change frequency abruptly and often. Their "dwell time" varies from a few seconds to a few minutes.

Money: This project is organized and staffed entirely by unpaid volunteers. We need your help to pay for printing, postage, etc. To raise money we are selling T-shirts with our symbol (at top, right) printed in red and black, for $10 each postpaid in North America. Arrangements for foreign distribution are still being explored. When ordering, please specify size (S/M/L), and make checks payable to "The Woodpecker Project" in US currency.

Additional copies of this announcement are available for 1 uncancelled 1st-class US postage stamp + a US-stamped self-addressed envelope; or 3 IRCs. We also encourage you to photocopy and distribute these sheets yourself.

Figure 5: Project Announcement and Description

Figure 6: Project Sign-Up and Interference Report Form

Report on "Woodpecker" Interference in a Shortwave Broadcasting Band

Affected station: ______________________ Affected frequency: __________

Strength of interference (1 = mild, 5 = overwhelming): 1 2 3 4 5
circle one

Date (UTC): ______________ Time (UTC): ________

Approximate duration of interference: ______________________________

Reporter's name: ____________________ Receiver model: ______________

Reporter's location (city, country): ______________________________

Complete and return by 1 November 1985 to: The Woodpecker Project
1634 - 15th St. NW
Washington, DC 20009 USA

To file additional reports, photocopy this form.

- - c - u - t - c - u - t - -

Sign-Up for the Woodpecker Monitoring Team

Name: __________________________ Years of SW listening experience: ____

Address: ________________________ Receiver model: ______________

________________________ Receiver's band coverage: __________

At right, put a "1" on the line that corresponds to the date/time which is your first choice for duty, "2" for your second choice, etc.

If you are willing to monitor for more than 3 hours, how many time-periods can you handle?: _____

We will try to schedule you according to your preferences, but we can accommodate only 48 monitors per time-slot, and other factors - like geographical distribution - must be considered, too. In general, our policy is "first come, first served", so don't delay! Send this completed form - along with a self-addressed US-stamped envelope, or 3 IRCs - to:

The Woodpecker Project
1634 - 15th St. NW
Washington, DC 20009 USA

October:	1	4	7	10	13
0000-0300:	____	____	____	____	____
0300-0600:	____	____	____	____	____
0600-0900:	____	____	____	____	____
0900-1200:	____	____	____	____	____
1200-1500:	____	____	____	____	____
1500-1800:	____	____	____	____	____
1800-2100:	____	____	____	____	____
2100-2400:	____	____	____	____	____
(UTC)					

We must hear from you by 15 August 1985. Time- and band-assignments will be mailed out 1 September 1985.

Feel free to photocopy and distribute these forms to other SW listeners.

for others who were unable to fulfill their monitoring assignment. Also, six monitors with access to oscilloscopes, and two more with access to spectrum analyzers, were asked to study and report on the Woodpecker signals during the scheduled monitoring period, but were not limited to any specific band-shift.

Report Forms. Simple graphic report forms were created on which the time and frequency of each encounter with a Woodpecker signal could be noted with a dot. The report form divided the assigned band into MHz, labelled according to the part of the spectrum the monitor was to scan, and each MHz was subdivided into 100 kHz segments. Similarly, the assigned time was divided into hours and subdivided into 10 minute segments. Examples of completed report forms appear on the following page (Figure 7).

Data Collected. One hundred and ninety-five completed report forms were turned in by 96 monitors from 18 countries[30]: 69 reports from 1 October, 39 from 4 October, 79 from 13 October 1985, and 8 from unscheduled monitoring between 3 and 23 October.[31] We also received many more informal reports about Woodpecker band use - some quite detailed - concerning a variety of time periods, plus reports from our oscilloscopers and spectrum analyzers, and from others who had heard about the project and wished to contribute their observations.

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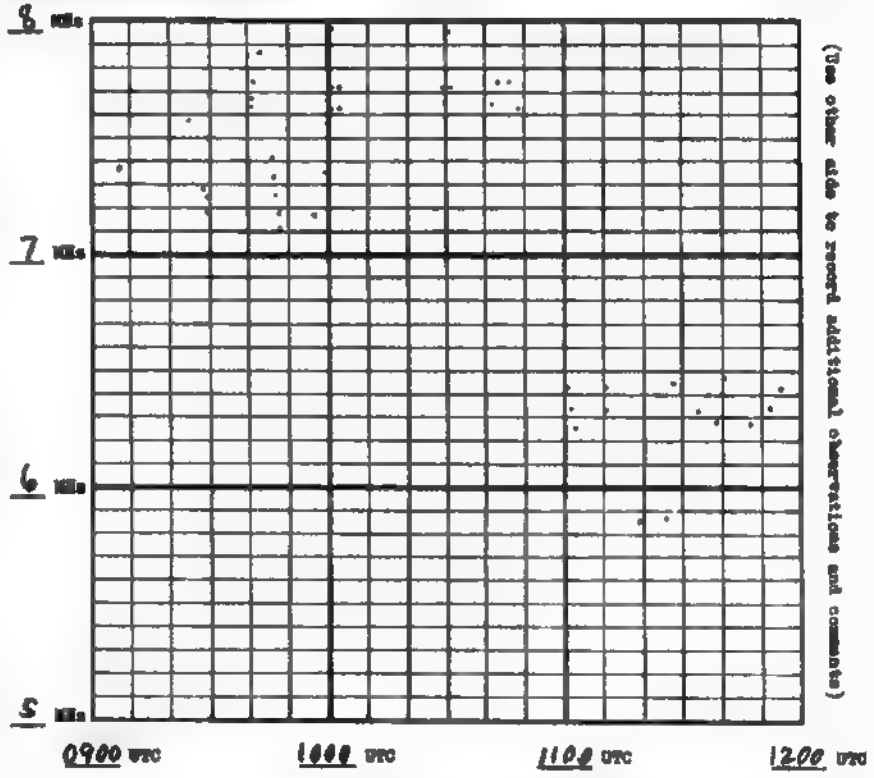
[30] The countries were: Argentina, Australia, Austria, Canada, Czechoslovakia, Federal Republic of Germany, France [French Polynesia], Ireland, Japan, Mexico, Netherlands, New Zealand, Norway, Sri Lanka, Sweden, Trinidad, United Kingdom and the United States.

[31] We told our monitors it would be helpful if they could check their assigned band at the same time on other days, and report on any similarities to or differences from their assigned band-shift.

Figure 7: Sample Monitoring Report Forms (completed)

Monitoring Report - The Woodpecker Project

Instructions: You are to monitor a 3 MHz portion of the shortwave spectrum for 3 hours, as indicated below. Sweep your assigned band however you like, so long as you tune every frequency at least once every 10 minutes. Whenever you hear a "Woodpecker", put a small distinct ink-dot on the grid to mark the frequency and time. If your monitoring is interrupted, note this by drawing vertical lines on the grid to show the time missed. Label the area between the lines "UNMONITORED". (For obvious reasons, please try to avoid interruptions.) Thanks for contributing your time and effort to this project. Even if you don't hear the "Woodpecker" during your sweeps, remember that that, too, is valuable information. Please return this form by 1 November 1985 to: The Woodpecker Project, 1634 15th St. NW, Washington, DC 20009, USA.

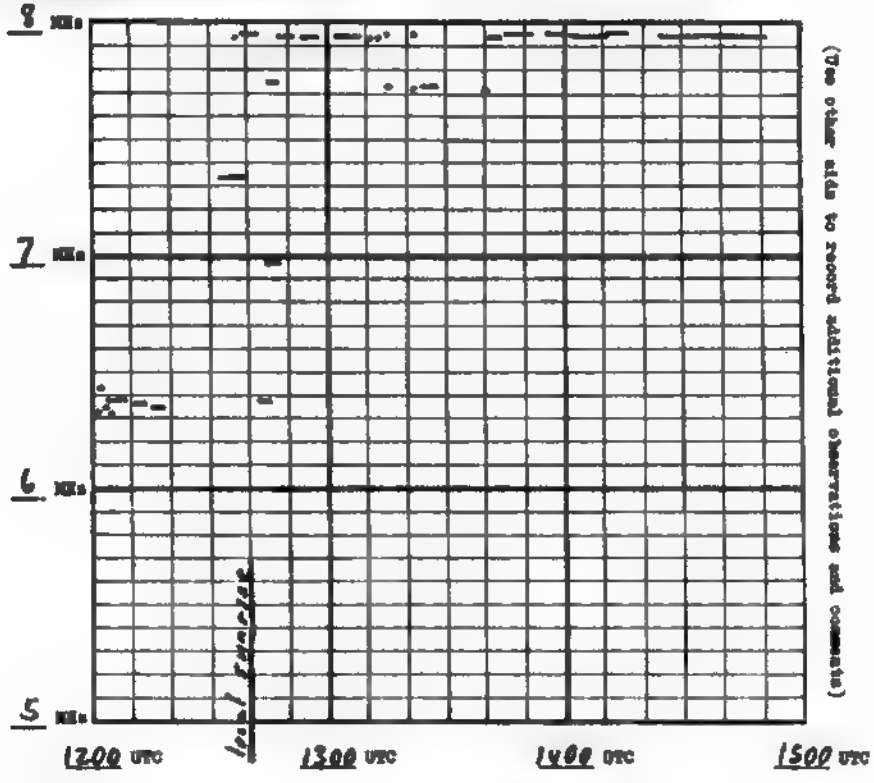


Date: 1 October 1985 Monitor: FREDERICK WHITE WDX-A13Z

City, Country: OLD ST. AUGUSTINE, FL (USA) Receiver: NRD-515

Monitoring Report - The Woodpecker Project

Instructions: You are to monitor a 3 MHz portion of the shortwave spectrum for 3 hours, as indicated below. Sweep your assigned band however you like, so long as you tune every frequency at least once every 10 minutes. Whenever you hear a "Woodpecker", put a small distinct ink-dot on the grid to mark the frequency and time. If your monitoring is interrupted, note this by drawing vertical lines on the grid to show the time missed. Label the area between the lines "UNMONITORED". (For obvious reasons, please try to avoid interruptions.) Thanks for contributing your time and effort to this project. Even if you don't hear the "Woodpecker" during your sweeps, remember that that, too, is valuable information. Please return this form by 1 November 1985 to: The Woodpecker Project, 1634 15th St. NW, Washington, DC 20009, USA.



Date: 1 October 1985 Monitor: CARL HUFFAKER

City, Country: MEXICO CITY, MEXICO Receiver: [illegible] DR-22

As the sample reports in Figure 7 suggest, the somewhat different logging styles of the monitors makes it hard to state precisely the total number of Woodpecker encounters reported, but it was certainly several thousand.

Analysis of Data

The reports were first screened to detect obvious misidentifications of the signal of interest and/or misinterpretations of the reporting procedure. Only one showed a pattern of activity blatantly unlike that usually associated with the Woodpecker. We contacted the monitor by telephone and established that this person did not know what the Woodpecker sounded like, so this report was disregarded.[32]

Worldwide Composite. The remaining 194 report forms were sorted in various ways to collate the data. The graph labelled "Worldwide Composite" (Figure 8, next page) shows where Woodpecker signals were observed by scheduled monitors on 1, 4 and 13 October 1985. To generate this graph, data in the reports was consolidated in the following manner: the spectrum from 5 to 23 MHz was divided into 250 kHz segments, and the 24 hours of the day were divided into half-hour periods. A graphic symbol specific to each day was put at the appropriate location in the grid of the composite if any monitor reported hearing a Woodpecker signal anywhere within that 250 kHz anytime during that half-hour. Additional reports falling within the same 250 kHz/half-hour data bin were not indicated unless they were from another day.

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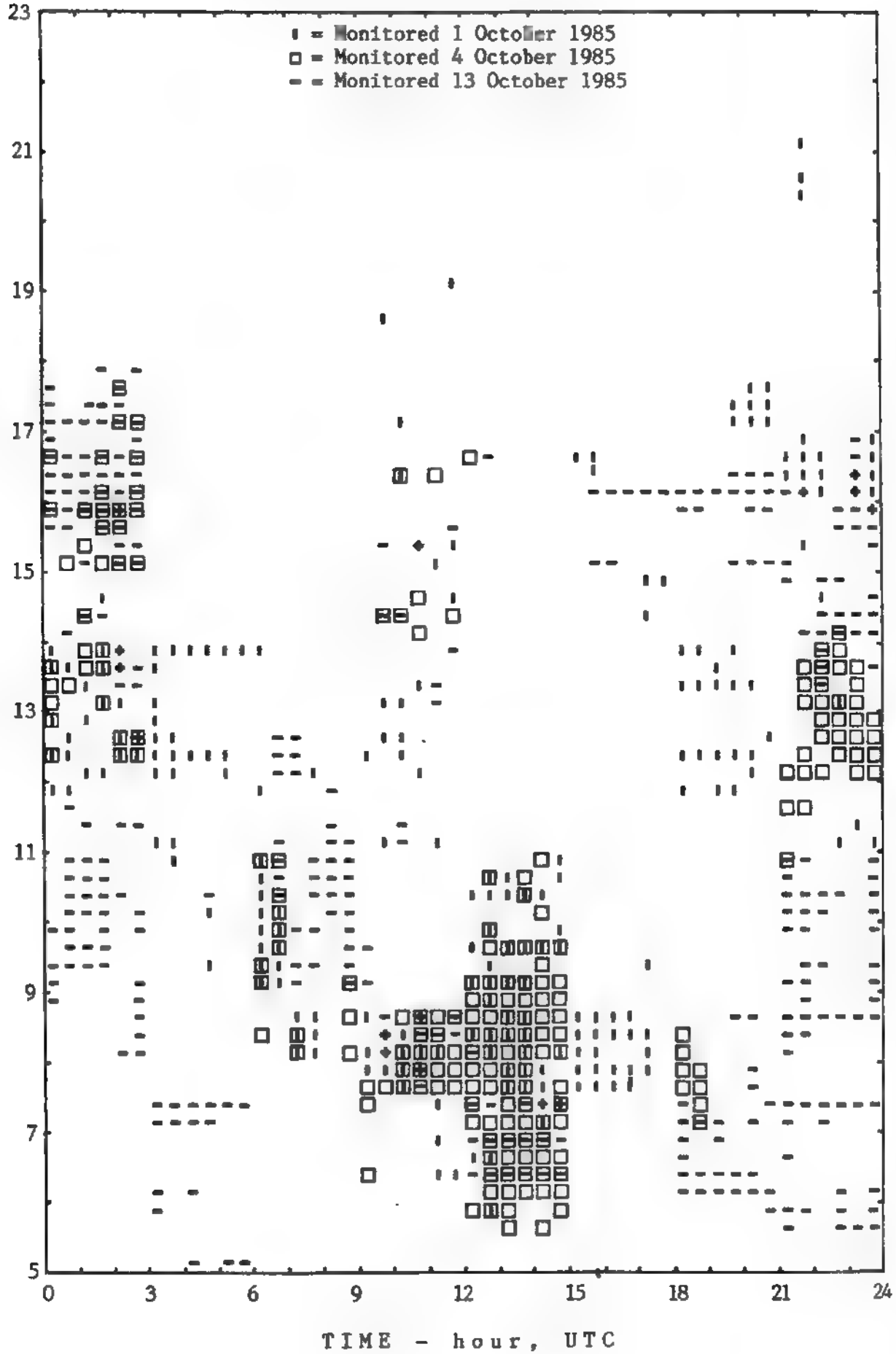
[32] Our monitoring sign-up forms asked how many years of shortwave listening experience each volunteer had. The average was 14.82 years. We believe the reports of such a seasoned group are in general highly reliable.

Figure 8: Worldwide Composite



Although this method sacrifices some of the resolution available in the raw data, it smoothes out variations in individual monitors' band-scanning and dotting methods, and makes the general pattern of Woodpecker band-use somewhat more visually apparent.

Beam Directionality. Such smoothing also brings out other general features of the graph. For example, the "Worldwide Composite" shows vertical discontinuities in reported Woodpecker activity every 3 hours. These coincide with our scheduled shift changes.

We reviewed our reports and procedures carefully to find an explanation for these shift-related discontinuities. Although a more thorough analysis would be necessary to eliminate alternative explanations, our tentative conclusion is that the discontinuities are not artifacts resulting from defects in our methods, but rather evidence that reception of Woodpecker signals varies significantly from place to place. During each shift, a different group of monitors was on duty. Our Regional sorts, described below, illustrate how strongly location affects the audibility of Woodpecker signals. In our view, then, the shift-related discontinuities are primarily due to the uneven geographic distribution of the signals themselves, made manifest by the abrupt changes in distribution of our monitors from one shift to the next.

Looking at the reports more carefully, we note that while widely separated monitors often hear Woodpecker transmissions in the same part of the spectrum, they rarely reported hearing the same specific transmissions. Further study is needed on this point, but we suspect that the patchiness of reception shown in our monitoring reports cannot be entirely explained by the

opening or closing of ionospheric paths between the transmitter and the monitor. When propagation is factored out, the remaining disparities may indicate that the Woodpeckers' radiation pattern is not omnidirectional. Indeed, it would be consistent with our data, and with the hypothesis that they are over-the-horizon radars, if their beams were concentrated in a particular direction and steerable.

To sum up: our reports show that while Woodpecker signals are heard around the world, particular transmissions are not heard everywhere. The opening and closing of ionospheric paths between transmitter and receiver for certain frequencies at certain times of day is probably the most important determinant of where the signals are heard, but beyond that there are indications that Woodpecker transmissions are not omnidirectional.

Day-to-Day Variations. The "Worldwide Composite" also shows many consistencies in Woodpecker activity from one shift to the next, as well as gradual progressions covering many hours. These are clear enough to reveal differences in Woodpecker band-use from one monitored day to another.

For example, on 13 October successive groups of monitors between 0000-0600 and 1800-2400 UTC reported the signals active on lower frequencies than during the same periods on the 1st and 4th. This might have been due to the geomagnetic storm activity noted in the NBS Solar-Terrestrial Report on 13 October. And at 1500-2100 UTC on each monitored day, the Woodpecker transmissions were in different bands. The latter time seems to mark a transition on each day from lower frequencies, suitable for nighttime propagation, to higher frequencies, suitable for day-paths. Night/day transition periods are often characterized by unstable propagation.

Overall Consistency. But beyond the discontinuities due to shift changes, and differences in frequency use from one day to another, one cannot help noticing the high degree of interlock and concurrence among the reports. Perhaps not surprisingly, the composite pattern seems to show a time-profile of frequency selections typical of transmissions designed to achieve skywave propagation to distant regions.

From 0000 to 0300 UTC, for instance, Woodpecker activity was concentrated between 9 and 18 MHz. From 0300 to 0900, the signals gradually moved down-band, and from 1200 to 1500, they were largely confined to the 5-11 MHz region. Although the pattern is more ambiguous from 1500 to 2400, the signals extend up-band, completing the cycle.

Locating the Active Sites. There are a few points in the graph where Woodpecker signals were noted on all three days: 15750-16000 kHz at 0200-0230 UTC; 12500-12750 kHz at 0230-0300; 7750-8000 and 8500-8750 kHz at 1030-1100; and 7250-7500 kHz at 1430-1500.

Correlating these points of concurrence with the general principles of ionospheric propagation, it seems likely that the path(s) from the transmitter(s) to the intended target area(s) were in darkness between 1030 and 1500 UTC, and in daylight at 0200.

A collection of sunrise-sunset maps published by the Ontario DX Association (one of ANARC's member clubs) indicates that this combination of hours of darkness and daylight only occurs in the eastern quarter of Asia and the Western Pacific.[33] From this we tentatively conclude that most of the

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[33] Cedric J. Marshall, Great Circle Sunrise-Sunset Maps, Ontario DX Association (Toronto, 1982)

Woodpecker signals monitored on the 1st, 4th and 13th of October came from the transmitter site in eastern Siberia.

But it is also significant that on all three days, a smattering of signals were monitored between 11 and 20 MHz at 0900-1200 UTC. If these reports are correct, they suggest transmissions from a second site, displaced from the first site by many time-zones. A second site might also be responsible for the signals monitored between 5 and 11 MHz at 1800-2400 UTC on 13 October. This secondary pattern is not as clear as the one we ascribe to the Siberian transmitter, but referring again to the sunrise-sunset maps, we see that it is consistent with a transmitter located in Eastern Europe or Western Asia.

Geographical Sorts. In order to refine our geographical analysis, we re-sorted our monitoring reports by ITU Region. The results are presented in a series of four graphs starting on the next page. Figure 9 is based on 31 reports by 18 monitors in Europe (Region 1); Figure 10, on 112 reports by 44 monitors in North and South America located east of 97 degrees West longitude (Region 2); Figure 11, on 32 reports by 23 monitors in Region 2 west of 97 degrees West longitude; and Figure 12 on 19 reports by 11 monitors in Asia (Region 3).[34]

Unlike the Worldwide Composite, where each day was graphically identified, in our geographic sorts the reports of the three monitoring days are combined. A dot indicates simply that a Woodpecker signal was heard in that 250 kHz band during that half-hour. Blank areas indicate that that

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[34] Region 2 was split into eastern and western sectors because of the large number of reports we had to work with.

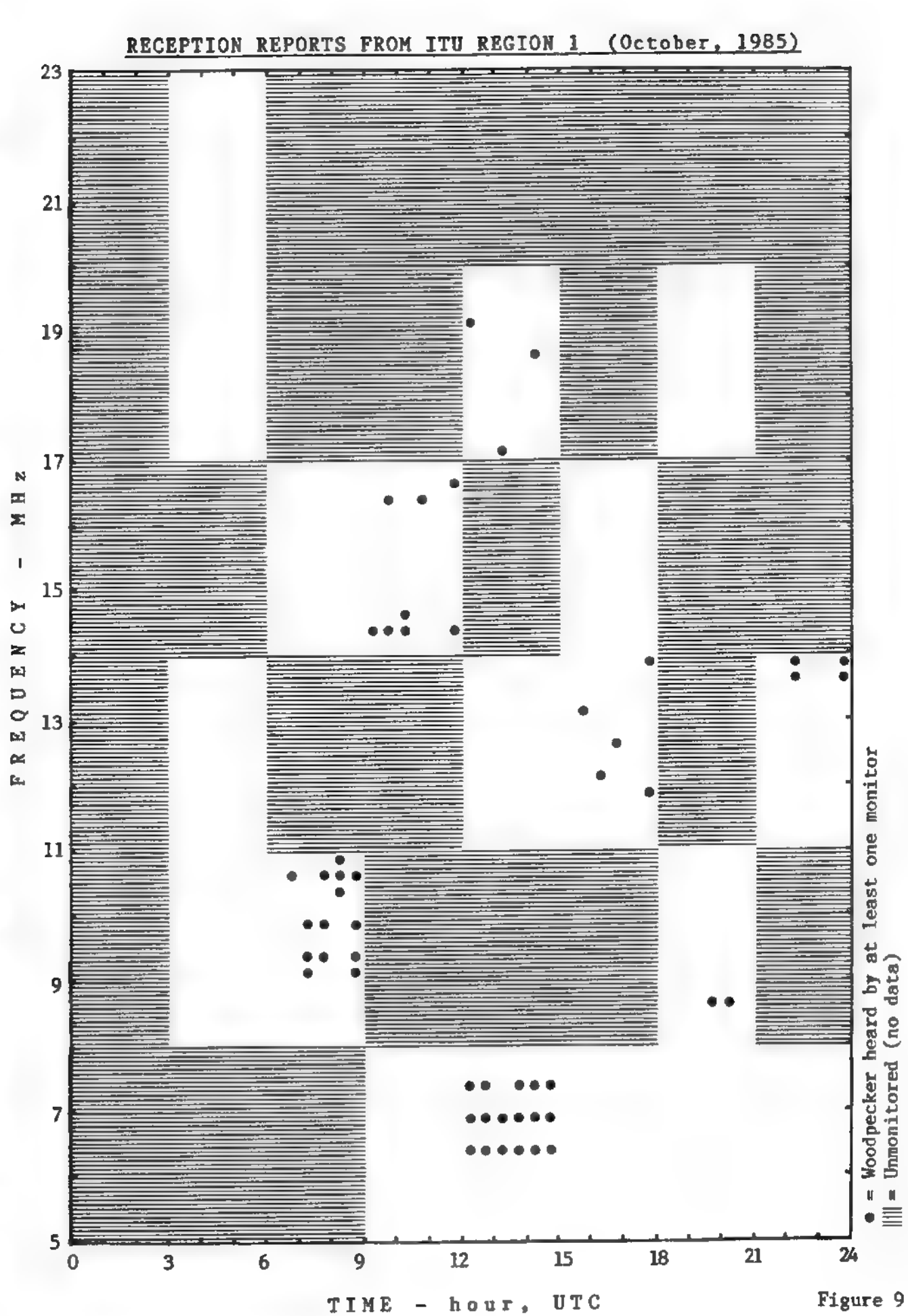
RECEPTION REPORTS FROM ITU REGION 1 (October, 1985)
FREQUENCY - MHz
23
21
19
17
15
13
11
9
7
5
0
3
6
9
12
15
18
21
24
TIME - hour, UTC
● = Woodpecker heard by at least one monitor
|||| = Unmonitored (no data)

Figure 9

RECEPTION REPORTS FROM ITU REGION 2 - East (October, 1985)

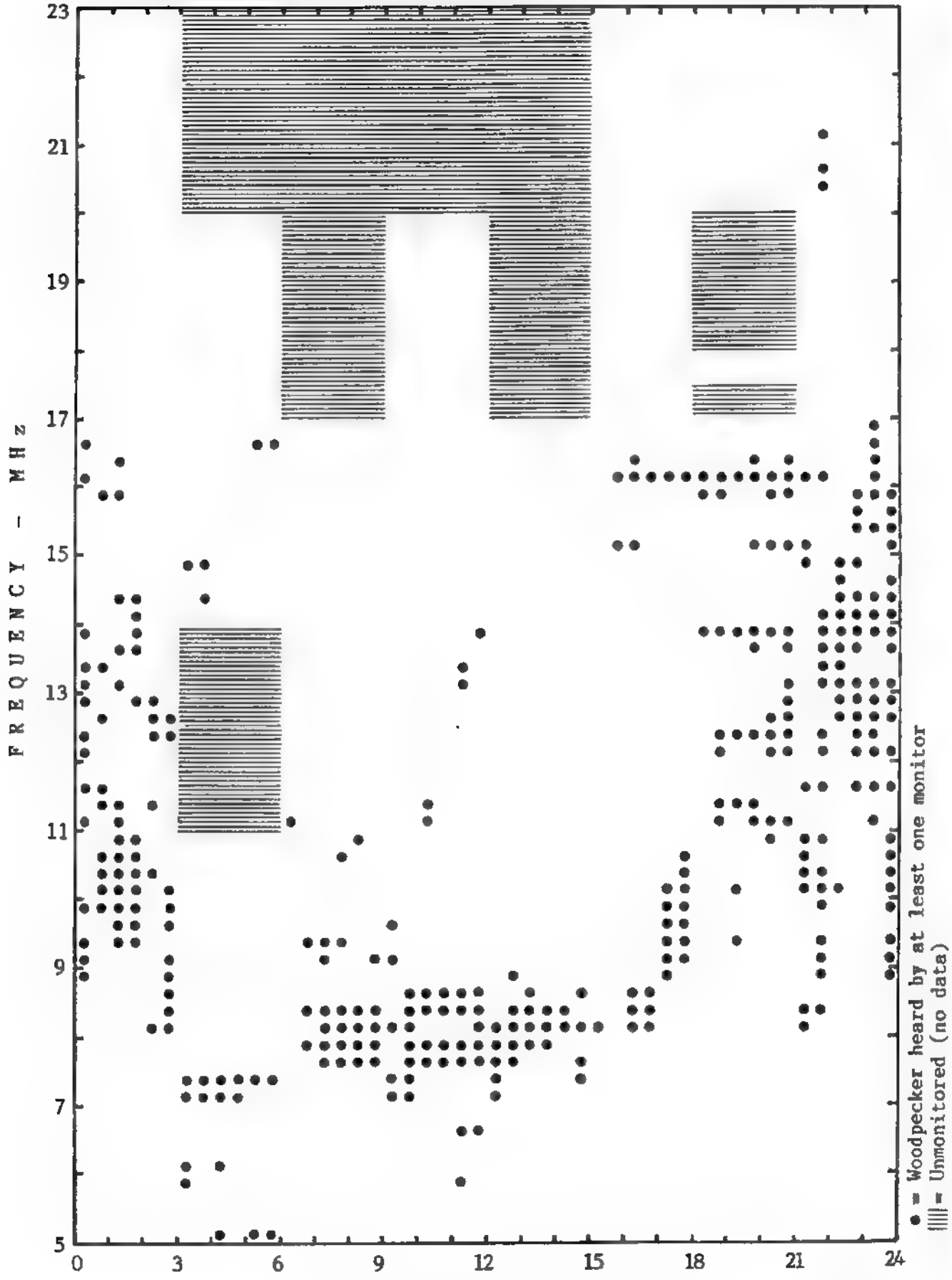

Figure 10

RECEPTION REPORTS FROM ITU REGION 2 - West (October, 1985)

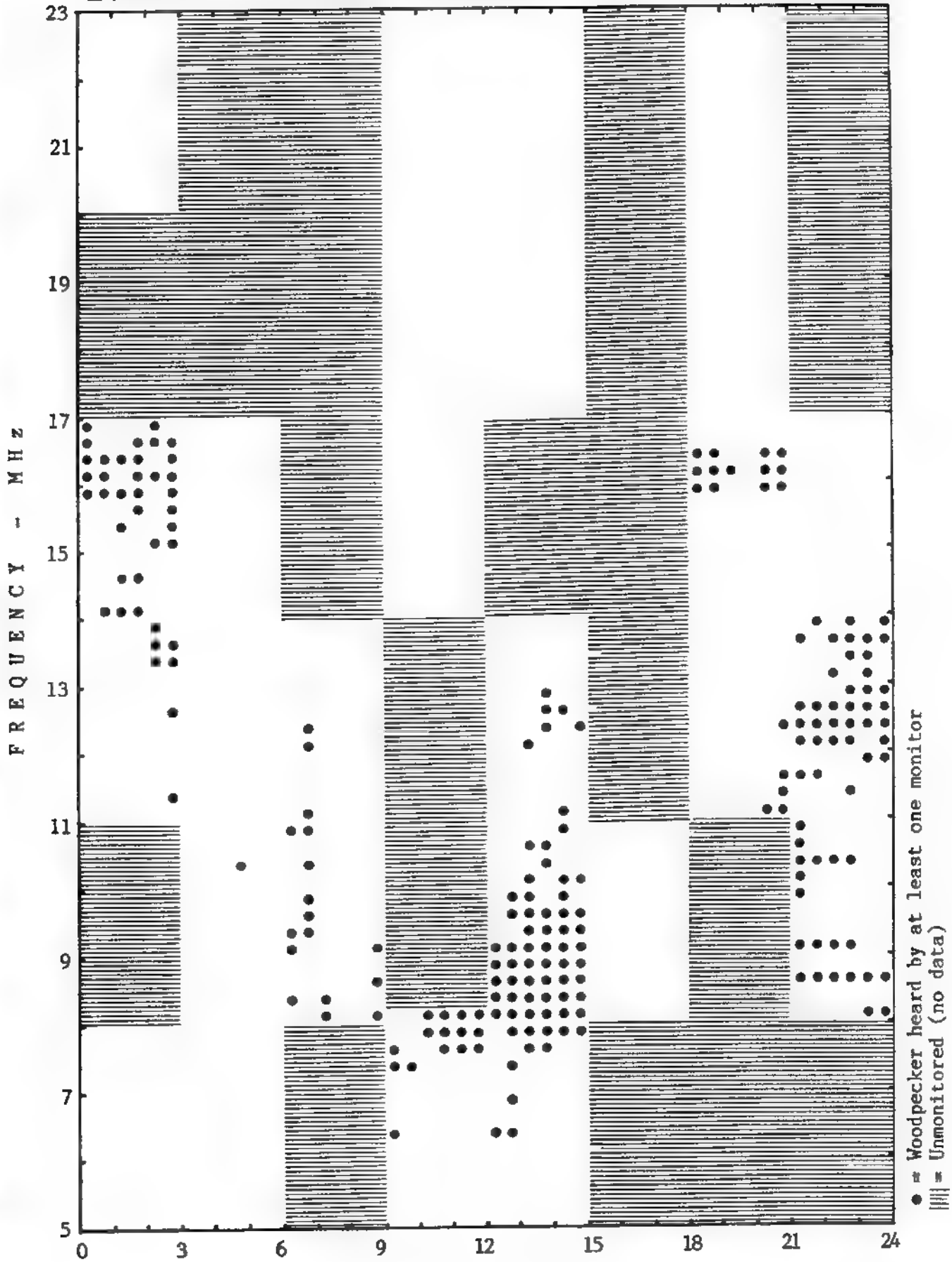

Figure 11

RECEPTION REPORTS FROM ITU REGION 3 (October, 1985)

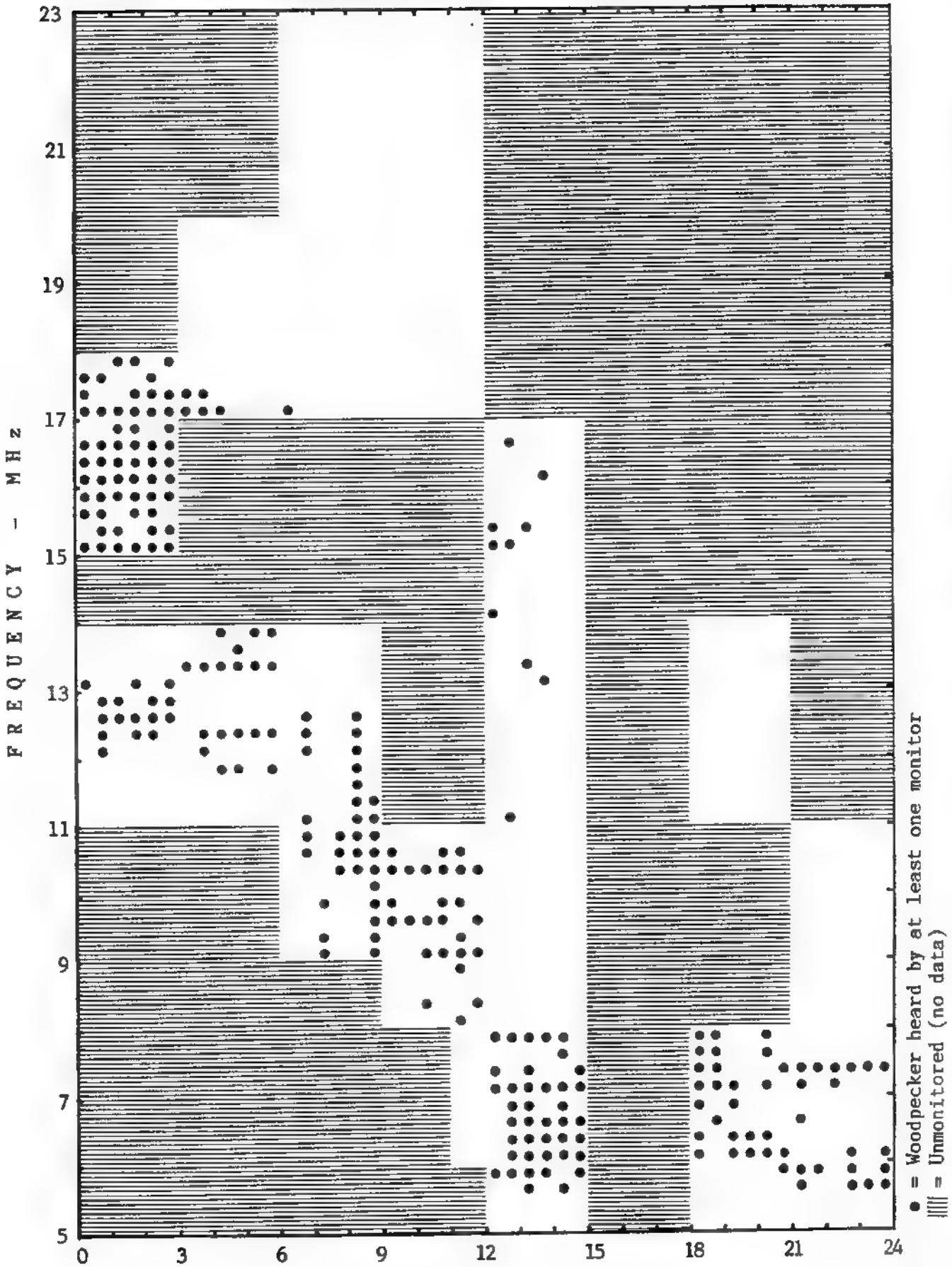

Figure 12

band-shift was monitored and no Woodpecker signals were heard. The shaded areas indicate band-shifts that were not monitored in that Region.

The results from Region 1 would have been a greater surprise if we had not already concluded that most of the reported signals were coming from eastern Siberia. Figure 9 shows that Woodpecker transmissions were rarely heard in Europe during our three days of monitoring. This was confirmed by many written comments filed with the Region 1 reports. For example, a monitor in England who checked his band (14-17 MHz) two days prior to and one day after his scheduled shift (1500-1800 UTC, 1 October) noted:

> "This lack of woodpecker signals on the band is a complete contrast to the situation on the same band a few months ago. The woodpecker signals could be heard in abundance at all times during the day and proved a considerable problem and source of interference to listening to other SW stations."

Most of the European monitors who heard Woodpecker signals during their shifts commented that they were much weaker than usual. The consistency of these reports leads us to think that the Woodpecker site near Kiev - the one most readily heard in Europe - was off the air during our monitoring exercise, and apparently for some months before it began. If a second site was active during our monitoring period, it probably was the one near the Black Sea. (More recent checks of the HF spectrum suggest that the site near Kiev is active once again.)

Reports from the eastern part of Region 2 during the October monitoring exercise show many encounters with the Woodpecker throughout the day, and a pattern of frequency use clearly conforming to a diurnal propagation cycle. A similar pattern is seen in the reports from the western part of Region 2, though not quite as distinctly, and shifted later in the day by a few hours.

This temporal displacement continues into Asia, with the monitoring reports from Region 3. It is unfortunate that we had no monitors scheduled below 11 MHz from 0000-0600, or above 11 MHz from 2100-2400 UTC, to confirm the closing of the diurnal cycle across 0000 UTC. The apparent discontinuity in band use, from low frequencies in the hours preceding UTC midnight to high frequencies in the hours just after midnight, may merely be due to the change in geographic distribution of our monitors from one shift to the next in those time-periods.[35]

Woodpeckers in the Broadcasting Service Bands

These observations concerning the Woodpeckers' overall band-use during the October monitoring periods provide a context for addressing the principal concern of this report: the Woodpeckers' presence in the bands allocated to the HF Broadcasting Service.

Starting on the next page, Figures 13-15 show the reports from our October monitoring of Woodpecker signals in the present and future bands allocated to the Broadcasting Service between 5 and 23 MHz. The frequency resolution of Figures 13-15 is 100 kHz. The temporal resolution is 30 minutes, but three sizes of dots are used to show approximately how much of each half-hour was affected by the Woodpeckers' presence. The smallest dot indicates that a Woodpecker signal was present somewhere in that 100 kHz band during one 10-minute period that half-hour; the middle-sized dot indicates

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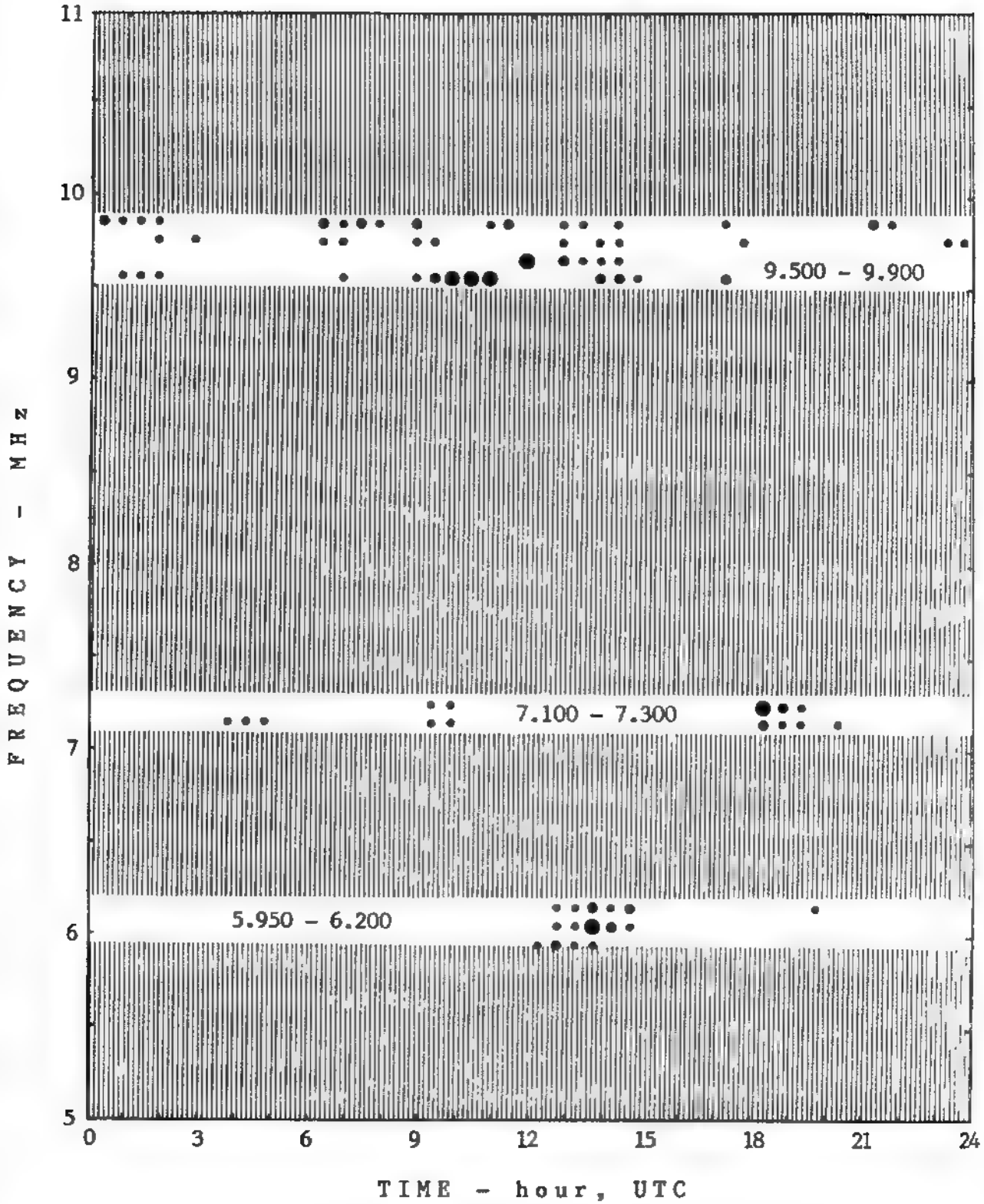
[35] Our Region 3 monitors at 2100-2400 UTC were located in New Zealand and Sri Lanka; at 0000-0300, in Australia and French Polynesia.

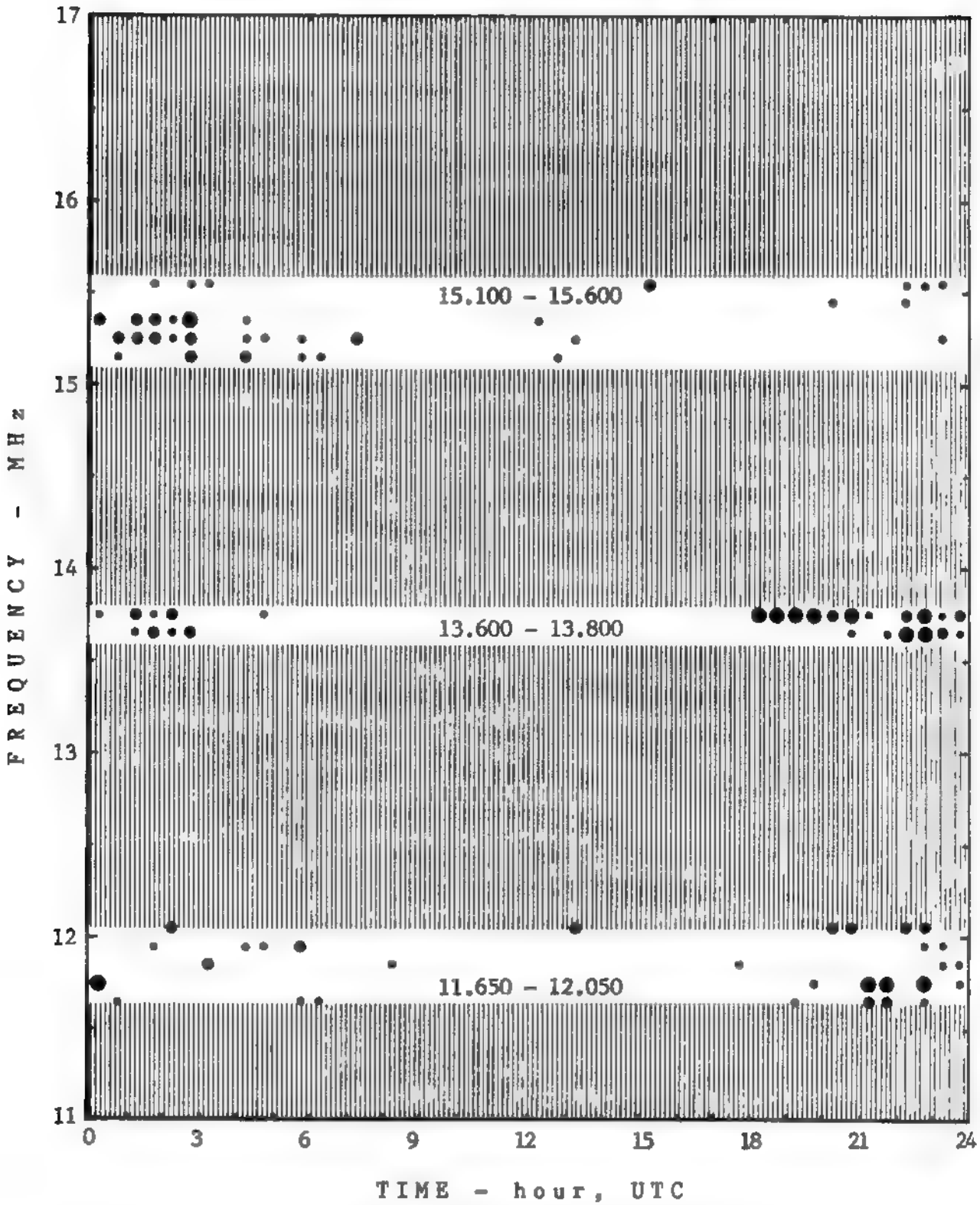
BROADCAST BAND REPORTS: 5-11 MHZ (October 1985)



• = Woodpecker monitored during one 10-minute period this half-hour
● = Woodpecker monitored during two 10-minute periods this half-hour
⬤ = Woodpecker monitored during three 10-minute periods this half-hour

Figure 13

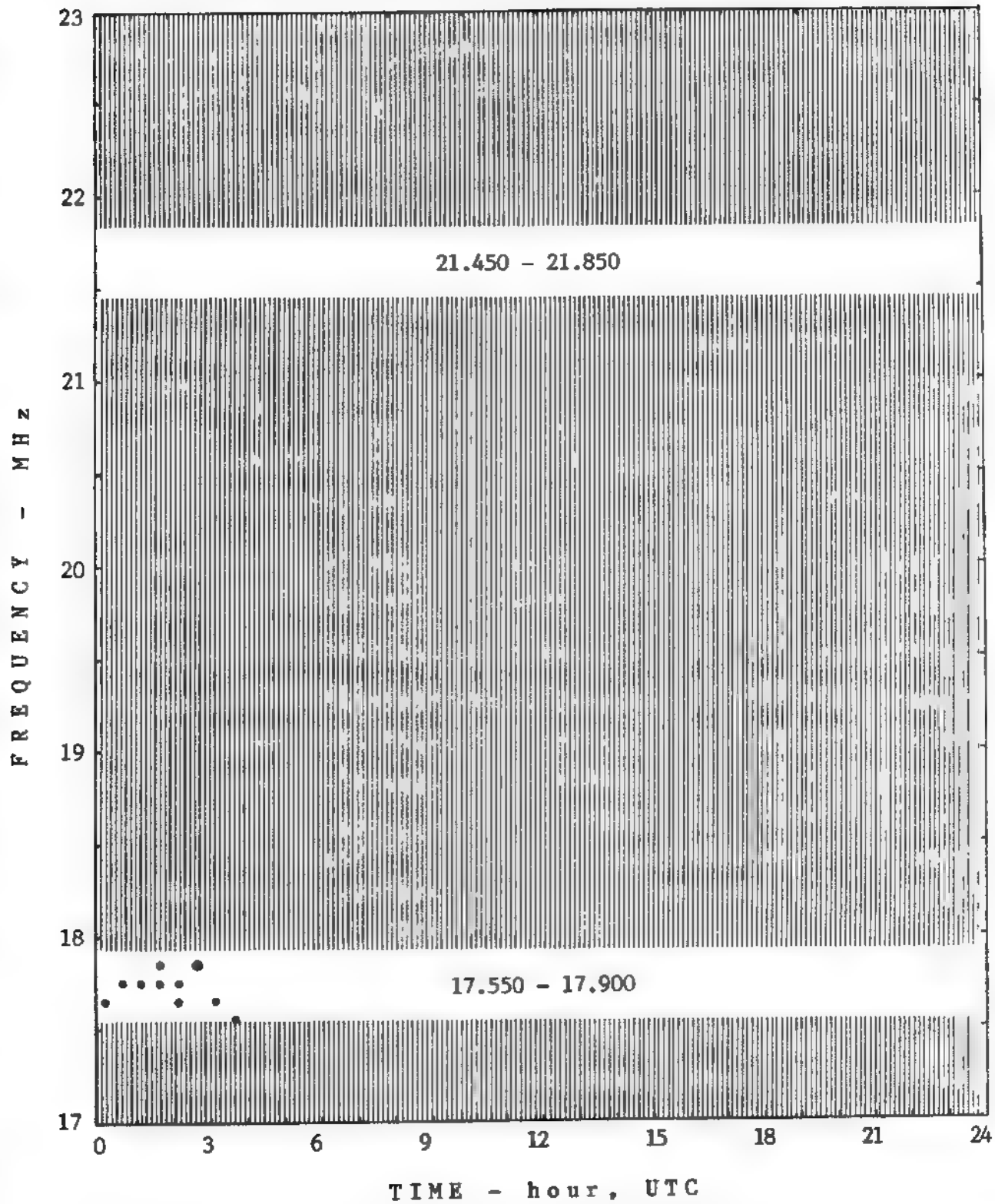
BROADCAST BAND REPORTS: 11-17 MHz (October 1985)



• = Woodpecker monitored during one 10-minute period this half-hour
● = Woodpecker monitored during two 10-minute periods this half-hour
● = Woodpecker monitored during three 10-minute periods this half-hour

Figure 14

BROADCAST BAND REPORTS: 17-23 MHz (October 1985)



• = Woodpecker monitored during one 10-minute period this half-hour
● = Woodpecker monitored during two 10-minute periods this half-hour
⬤ = Woodpecker monitored during three 10-minute periods this half-hour

Figure 15

it was noted during two 10-minute periods that half-hour; the largest dot indicates it was heard in all three 10-minute periods that half-hour.

Though these graphs should be self-explanatory, a few comments are in order. No Woodpecker signals were reported in the 21450-21850 kHz band. This is no doubt due to poor propagation at those frequencies because of the sunspot cycle.

Reports of Woodpecker signals in the 17550-17900 kHz band all came from Asia and were limited to 0000-0400 UTC.

The 15100-15600 kHz band experienced Woodpecker interference quite often, in all Regions, during our monitoring, especially from 2100-0800 UTC.

The 13600-13800 kHz band is not yet officially open for broadcasting. We include it anyway, since some broadcasters are already operating there, and the Woodpeckers' extensive use of the band may foreshadow interference problems in the future.[36]

Woodpecker signals were often heard in the 11650-12050 kHz band between 1800 and 0600 UTC, especially in the edges of the band. As with the 13 MHz band, 11650-11700 and 11975-12050 kHz have been allocated for future use by the Broadcasting Service, stations are moving in already, but the expansion bands are not yet fully utilized.

The Woodpecker was reported in the 9500-9900 kHz band more often than in any other Broadcasting band, especially in the 9775-9900 kHz expansion band.

Although Woodpecker signals were noted in the 7100-7300 and 5950-6200 kHz bands, they were heard much less often than in previous years. The

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[36] On the other hand, the Woodpeckers' heavy use of this band from 1800-0300 UTC may be due to the fact that it is not yet filled with Broadcasting stations.

apparent absence of signals from the Kiev-area transmitter during our monitoring period may partly explain this departure from historical patterns.

A preference for less-occupied parts of the Broadcasting Service spectrum suggests that the Woodpeckers' own operations may be affected by the presence of other powerful transmissions and/or densely packed stations. Similarly, although we cannot yet verify this with reliable measurements, we suspect that the Woodpeckers operate proportionally less in the Broadcasting Service bands than in the Fixed Service bands.

On the other hand, after hours of visual tracking with a spectrum analyzer, we saw no evidence that the Woodpeckers' operators avoid using channels occupied by communications stations when transmitting in partially occupied bands. Since they spend so much time operating on occupied channels in both partially and fully occupied bands, any procedure they may be following to avoid interference cannot be considered effective.

In sum, while we have not yet devised a rigorous method for determining if the Woodpeckers' use of frequencies allocated to the Broadcasting Service is proportionally less or greater than their use of frequencies allocated to other services, our monitoring reports suggest a slight preference for operation in less-occupied bands. We must emphasize the slightness of the tendency, as our monitoring also shows the Woodpeckers operating in the most heavily used Broadcasting bands on a daily basis. The 9, 11 and 15 MHz bands are particularly affected.

Reports of Interference to Broadcasting Stations

In addition to our scheduled monitoring, we invited shortwave listeners

to send us reports of Woodpecker interference to stations in the Broadcasting Service whenever they observed it. Simple report forms, like the one shown at the top of page 23, were mailed out to all who inquired about our project, whether or not they volunteered for scheduled monitoring.

The interference report forms asked for the name of the affected station, its frequency, the relative strength of the interference (on a subjective scale of 1 to 5, with 1 being "mild" and 5 being "overwhelming"), as well as the date, time and duration of the interference, the monitor's location, and the type of receiver used. Several hundred copies of this form were mailed out between 1 June and 1 September 1985.

Screening the Reports. One hundred and forty-two reports of Woodpecker interference to broadcasting stations were received by our closing date of 1 November 1985. Each one was checked against the schedule and frequency information contained in the 1985 and 1986 editions of the World Radio-TV Handbook (Billboard Publications, New York, NY, USA); the 1985 and 1987 editions of Radio Database International (International Broadcasting Services, Ltd., Penn's Park, PA, USA); and the S85 edition of the International Listening Guide (DX Listeners Service, Homberg, West Germany). Reports concerning stations not confirmed as operating on the reported frequency by at least one of these publications were discounted, although they may well have represented actual incidents of interference to a broadcaster. Reports of interference to stations other than broadcasters (such as Fixed, Maritime and Amateur stations) were also set aside, as were reports of interference to stations operating in the Tropical bands below 5060 kHz.

Results. The ninety-nine reports that passed this screening process are listed below in Table 1, ordered alphabetically by the Administration authorizing the station and by station name.

Because this sample represents Woodpecker interference observed in the normal course of broadcast listening - not during systematic band-scans - it is necessarily incomplete, and subject to biases that are difficult to weigh and eliminate. These are discussed in more depth below. While it seems safe to say that the reports we received represent but a tiny fraction of the interference actually caused during this period, we have no way to project from this sample the total rate of interference to any station, let alone to stations in the Broadcasting Service in general.

Keeping these caveats in mind, our screened sample shows that Radio Australia had the most reports of interference (17), followed by the BBC (12), VOA (9), Radio Japan (8), Radio Moscow (7), Radio Beijing (6), Radio Tirana (5) and Radio Nederland (4).

Among these most-often-reported stations, the interference was strongest - that is, the average subjective signal strength, relative to the broadcast signal, was highest - for Radio Nederland (3.75), followed by Radio Beijing (3.4), Radio Australia (3.125), Radio Japan (3.125), Radio Moscow (3.0), VOA (3.0), Radio Tirana (2.6), and the BBC (2.54).

From these two basic measures - the number of interference reports per station, and the average reported strength of the interference - we conclude that while all of the major international broadcasters were subject to interference from Woodpecker signals in the fall of 1985, the major Asian broadcasters suffered disproportionately from the signals in this period.

Table 1: REPORTS OF WOODPECKER INTERFERENCE TO BROADCASTING STATIONS

Station (Country)	Freq.	S*	Date	UTC	Monitor's Location
R. Tirana (Albania)	7065	3	17 Aug	1643	Colombo, Sri Lanka
R. Tirana	7065	3	17 Aug	1647	Colombo, Sri Lanka
R. Tirana	7065	2	17 Aug	1653	Colombo, Sri Lanka
R. Tirana	7065	2	17 Aug	1700	Colombo, Sri Lanka
R. Tirana	7080	3	2 Oct	0643	Tasmania, Australia
R. Australia (Australia)	7205	5	23 July	1159	San Antonio, TX, USA
R. Australia	6045	4	21 Sept	1607	Takapoto, Fr. Polynesia
R. Australia	15320	2	24 Sept	0429	Takapoto, Fr.Polynesia
R. Australia	15320	4	1 Oct	0014	Manassas Park, VA, USA
R. Australia	9680	-	3 Oct	0511	Camas, WA, USA
R. Australia	15240	3	5 Oct	0251	Takapoto, Fr. Polynesia
R. Australia	6060	4	6 Oct	1510	Seattle, WA, USA
R. Australia	15320	4	10 Oct	0120	Takapoto, Fr. Polynesia
R. Australia	5995	2	12 Oct	1600	Takapoto, Fr. Polynesia
R. Australia	15240	4	13 Oct	0548	Takapoto, Fr. Polynesia
R. Australia	15320	3	18 Oct	0420	Takapoto, Fr. Polynesia
R. Australia	15240	3	19 Oct	0402	Takapoto, Fr. Polynesia
R. Australia	6060	4	21 Oct	1535	Seattle, WA, USA
R. Australia	6060	4	22 Oct	1545	Seattle, WA, USA
R. Australia	9580	1	27 Oct	1347	Edina, MN, USA
R. Australia	9580	2	27 Oct	1512	Edina, MN, USA
R. Australia	9580	1	27 Oct	1554	Edina, MN, USA
ORF (Austria)	9625	3	9 Oct	0832	Dural, Australia
R. Sofia (Bulgaria)	11750	5	19 Aug	2000	Seattle, WA, USA
R. Sofia	7135	3	29 Sept	0935	Mar Del Plata, Argentina
R. Sofia	9700	3	12 Oct	0015	Halifax, NS, Canada
CFRX (Canada)	6070	3	6 Oct	1519	Minneapolis, MN, USA
CFRX	6070	3	12 Oct	1541	Minneapolis, MN, USA
CFRX	6070	4	26 Oct	1355	Minneapolis, MN, USA
CHU	7335	3	1 Oct	1500	Sioux Falls, SD, USA
R. Canada International	7155	4	2 Oct	0620	Takapoto, Fr. Polynesia
R. Beijing (China)	15880	4	21 Sept	0646	Takapoto, Fr. Polynesia
R. Beijing	11375	5	1 Oct	0040	E. Meadows, NY, USA
R. Beijing	15520	3	10 Oct	0309	Takapoto, Fr. Polynesia
R. Beijing	15510	3	15 Oct	0015	Takapoto, Fr. Polynesia
R. Beijing	9945	4	19 Oct	0000	St. John, NB, Canada
R. Beijing	9700	4	20 Oct	0849	Takapoto, Fr. Polynesia

*Strength of interference (1 = mild, 5 = overwhelming)

Station (Country)	Freq.	S	Date	UTC	Monitor's Location
R. Prague (Czechoslovakia)	11990	2	17 Jun	0158	San Antonio, TX, USA
R. Cairo (Egypt)	9805	1	22 Oct	2255	St. John, NB, Canada
R. Berlin Int'l (Germany E.)	21540	4	23 Oct	0850	Calicut, India
Deutsche Welle (Germany W.)	21560	3	22 Oct	1001	Calicut, India
All India Radio (India)	11620	5	18 Oct	1927	St. John, NB, Canada
R. Rep. Indonesia (Indonesia)	5256	4	11 Oct	1357	Alameda, CA, USA
R. Baghdad (Iraq)	11750	5	19 Aug	2000	Seattle, WA, USA
Kol Israel (Israel)	11605	3	22 Oct	2245	St. John, NB,, Canada
RAI (Italy)	11800	1	13 Jun	0316	San Antonio, TX, USA
R. Japan (Japan)	15300	2	3 Oct	0139	Camas, WA, USA
R. Japan	17810	4	14 Oct	0510	Takapoto, Fr. Polynesia
R. Japan	17810	4	14 Oct	0515	Takapoto, Fr. Polynesia
R. Japan	17810	3	14 Oct	0519	Takapoto, Fr. Polynesia
R. Japan	17810	3	14 Oct	0549	Takapoto, Fr. Polynesia
R. Japan	17810	2	14 Oct	0551	Takapoto, Fr. Polynesia
R. Japan	17810	4	15 Oct	0523	Takapoto, Fr. Polynesia
R. Japan	17810	3	18 Oct	0502	Takapoto, Fr. Polynesia
R. Pyongyang (Korea North)	6600	1	21 Sept	0747	Takapoto, Fr. Polynesia
R. Pyongyang	11655	4	3 Oct	0600	Seattle, WA, USA
R. Malaysia (Malaysia)	7295	2	13 Sept	1055	Takapoto, Fr. Polynesia
XEQK (Mexico)	9555	5	3 Aug	1603	San Antonio, TX, USA
R. Nederland (Netherlands)	9715	5	25 Sept	0605	Takapoto, Fr. Polynesia
R. Nederland	15560	3	12 Oct	2228	San Antonio, TX, USA
R. Nederland	21485	4	22 Oct	1106	Calicut, India
R. Nederland	21485	3	23 Oct	0905	Calicut, India
R. New Zealand (New Zealand)	15150	4	26 Sept	0459	Takapoto, Fr. Polynesia
R. New Zealand	15150	4	13 Oct	0600	Takapoto, Fr. Polynesia
R. Pakistan (Pakistan)	17660	5	28 Sept	0507	Takapoto, Fr. Polynesia
FEBC (Philippines)	15310	2	17 Aug	0440	Colombo, Sri Lanka
FEBC	15345	3	16 Sept	0151	Takapoto, Fr. Polynesia

Station (Country)	Freq.	S	Date	UTC	Monitor's Location
Voice of Free China (Taiwan)	15270	2	16 Sept	0200	Takapoto, Fr. Polynesia
Voice of Free China	7130	3	3 Oct	0903	Hornsby, Australia
R. Moscow (USSR)	12050	2	17 Jun	0204	San Antonio, TX, USA
R. Moscow	15465	2	18 Jun	2003	San Antonio, TX, USA
R. Moscow	15265	3	21 Jun	0103	San Antonio, TX, USA
R. Moscow	7200	3	23 July	1123	San Antonio, TX, USA
R. Moscow	7200	5	23 July	1142	San Antonio, TX, USA
R. Moscow	13655	2	3 Aug	2042	San Antonio, TX, USA
R. Moscow	15170	4	26 Sept	0408	Colombo, Sri Lanka
BBC (United Kingdom)	15310	2	19 Aug	0721	Colombo, Sri Lanka
BBC	15310	1	19 Aug	0723	Colombo, Sri Lanka
BBC	15310	2	19 Aug	0708	Colombo, Sri Lanka
BBC	15310	1	19 Aug	0705	Colombo, Sri Lanka
BBC	9740	4	23 Aug	1445	Ahmedabad, India
BBC	7180	2	19 Sept	1532	Colombo, Sri Lanka
BBC	9510	3	24 Sept	1209	Tasmania, Australia
BBC	9510	2	25 Sept	0610	Takapoto, Fr. Polynesia
BBC	9510	5	1 Oct	0604	Lake Helen, FL, USA
BBC	7150	3	2 Oct	0602	Takapoto, Fr. Polynesia
BBC	9410	3	6 Oct	0756	Taunusstein, W. Germany
BBC	7105	-	13 Oct	0420	Pompano Beach, FL, USA
AFRTS (USA)	21670	4	22 Oct	1122	Calicut, India
AFRTS	9930	4	22 Oct	2231	St. John, NB, Canada
KTWR [Guam]	9870	1	25 Sept	1412	Colombo, Sri Lanka
KYOI [Saipan]	15190	3	15 Oct	0448	Takapoto, Fr. Polynesia
RFE/RL	9725	2	1 Oct	1759	Chapel Hill, NC, USA
VOA	15205	4	17 Aug	0520	Colombo, Sri Lanka
VOA	9760	4	13 Sept	1852	Colombo, Sri Lanka
VOA	15375	3	16 Sept	0060	Takapoto, Fr. Polynesia
VOA	15580	2	21 Sept	2212	Takapoto, Fr. Polynesia
VOA	15160	1	26 Sept	0404	Colombo, Sri Lanka
VOA	9505	5	1 Oct	0604	Lake Helen, FL, USA
VOA	9670	3	3 Oct	0511	Camas, WA, USA
VOA/R. Marti	6075	3	5 Oct	1100	Alameda, CA, USA
VOA	9575	2	16 Oct	1620	Takapoto, Fr. Polynesia
WRNO	9715	-	27 Oct	1402	Edina, MN, USA
WWV	15000	1	14 Oct	2215	Halifax, NS, Canada

It is also interesting to note that Radio Moscow was subject to a significant amount of Woodpecker interference. This suggests that the Woodpeckers are not causing interference intentionally: why would the Soviet Union deliberately jam its own international broadcasting service, and those of its allies (Radio Prague, Radio Sofia)? Our sample shows that the interference is quite indiscriminate.

Discussion of Sample Bias. If Woodpecker interference to stations in the Broadcasting Service is nonselective, the frequency of interference to a particular station might simply be a function of the number of channel-hours the station is on the air. By this argument, Radio Moscow should be subject to Woodpecker interference about 14.4 times as often as Radio Australia.[35] However, as noted above, we received 17 reports of interference to Radio Australia and 7 reports to Radio Moscow. How can we explain this departure from a distribution predicted by random impacts weighted by the rate of channel occupancy? Do our reports indicate selective targeting of stations after all, or is our sampling biased?

For a reporter to notice Woodpecker interference to a broadcasting station, he must have been listening to that station prior to the incident, or to a station on a nearby frequency, or perhaps he was just browsing about the bands. The chances of the interference being noticed in the first place thus depend crucially on the preferences and habits of those listening.

While one could regard listener preferences as biasing measurements of the rates of interference to broadcasting stations, it is important to

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[35] Based on figures for the number of scheduled hours for these stations listed in Radio Database International (1987 edition), pages 332-333.

realize that the effect of interference is to degrade reception. If a Woodpecker signal is superimposed on the signal of a broadcasting station to which no one is tuned, it is not causing interference. Conversely, when a Woodpecker is co-channel with a station to which large numbers of people are tuned, it will cause more interference than when it is co-channel with a station with fewer listeners.

The question of bias properly enters when we consider that the listening preferences and habits of those reporting interference to us may not be typical of shortwave listeners in general. Unfortunately, information about the overall listening preferences of shortwave listeners is sketchy at best, and of uncertain reliability where it exists at all. Nor did we ask our reporters about their listening habits. We must look to demographic and other factors differentiating our reporters from shortwave listeners in general for clues as to how representative their reports are.

For example, all those reporting interference to us were English-speakers. Thus, they might have been more likely to notice interference to broadcasts in English than to broadcasts in other languages. Likewise, a disproportionate number are located in North America. This geographic concentration skews the role propagation plays in determining the audibility of stations and the Woodpecker signals in other regions, where the majority of shortwave listeners live.

Moreover, simply by filing an interference report our twenty reporters have shown themselves to be "activists." We aren't sure how this might affect their listening habits, but it may indicate that they spend more time

exploring the spectrum than the average listener, as opposed to primarily tuning for a few favorite stations, or only for the loudest and clearest.

Judgments about how to report interference incidents are also a skewing factor: some monitors treated intermittent interference as separate events, while others reported it as a single event.

It is unlikely that reports from as few as twenty people accurately represent the interference experienced by the millions of shortwave listeners, so we are reluctant to generalize from this small sample. It simply represents the response to our general call for reports. If shortwave listeners were not already so discouraged about the prospects for mitigating the interference, we believe we would have gotten a great many more. Nevertheless, interference to thirty-five stations indicates that the problem, after almost ten years, is still widespread, irritating and persistent.

Conclusion

Since July 1976, a distinctive type of high-powered pulse emission has plagued the HF band. Nicknamed the "Woodpecker" because of the sound it makes on communications receivers, the bandwidth of the emission is variable but relatively wide (typically 15–70 kHz). The pulse rate is normally 10 per second. Heard around the world, these signals step and dwell erratically between 5 to 28 MHz, causing harmful interference to all HF communications services on a daily basis.

In correspondence with the ITU, the Administration of the Soviet Union has acknowledged that these signals emanate from "test" stations engaged in radio propagation research within their territory. Others suspect that there

are three transmitter sites, and that the Woodpeckers are over-the-horizon radars. Whatever their purpose, the International Frequency Registration Board issued a report in 1977 finding that the stations should "cease operation until such steps have been taken to ensure that any interference that may result from the resumption of such tests shall be below the level that would be considered as harmful interference." This has not occurred.

The Association of North American Radio Clubs established the Woodpecker Project to study the problem of Woodpecker interference and present this report to the Delegates attending the 1987 World Administrative Radio Conference for High Frequency Broadcasting.

A coordinated monitoring exercise was organized in October 1985, to gather current information about the Woodpeckers' band use. Ninety-six shortwave listeners in 18 countries scanned the spectrum between 5 and 23 MHz for a total of 72 hours, noting when and where they heard the signals. The composite of their reports suggests one and possibly two cycles of frequency selection. The timing of the high- and low-points of the dominant cycle suggests that most of the signals monitored on 1, 4 and 13 October came from the suspected site in eastern Siberia. The small number of loggings from Europe, affirmed by written reports from that area, suggests that the suspected transmitter site near Kiev was not active during our monitoring period.

In addition to studying overall band use, we invited shortwave listeners to send us reports of interference to stations in the Broadcasting Service occurring between 1 June and 1 November 1985. Ninety-nine reports of interference to 35 stations were received from 20 listeners. While we cannot

project real rates of interference to broadcasters and their audiences from so small sample, we note that stations in Asia (especially Radio Australia, Radio Beijing and Radio Japan) seemed to suffer disproportionately from Woodpecker interference during this period.

In general we found that reception of specific Woodpecker transmissions varies from place to place, apparently due to anisotropic radiation patterns and ionospheric scattering. There seems to be a slight tendency for the transmissions to favor bands less crowded that those of the Broadcasting Service, but the Woodpeckers frequently operate on occupied channels in the Broadcasting bands nonetheless. Such operation invariably causes harmful interference, given the strength and bandwidth of the signals.

The Delegates of six Member Administrations of the ITU signed a statement in the Final Protocol of the 1978 World Administrative Radio Conference for Aeronautical Mobile (R) Services expressing "great concern about this prolonged violation". Eight years later, the interference persists, and two similar transmitting stations have apparently started operation since the ITU last addressed the problem.

As the Delegates to the HF Broadcasting Conference meet to seek ways to improve reception and reduce interference for the stations in the Broadcasting Service, we urge them to state their objections to the continuation of the above-described pulse interference in the Conference's Final Protocol. Language such as the following might serve to thwart the establishment of the level of interference associated with the so-called "Woodpeckers" as an acceptable precedent for other test and research stations, over-the-horizon radars, and similar systems in coming years:

"High-powered pulse transmissions within the HF Broadcasting Service bands are incompatible with the rational utilization of those bands by stations in the Broadcasting Service. Elimination of these emissions is essential to the development and implementation of effective plans for the HF broadcasting bands."

A C K N O W L E D G M E N T S

Many more people contributed to the Woodpecker Project than can be acknowledged here. In particular, we must thank the many radio publications and broadcasters that publicized our call for volunteers. A complete list of these is impossible, since in many cases they acted on their own initiative: aiding us without our knowledge. We owe a special debt to the following, for advice, equipment, information and/or material support: AM Press/Exchange, American Short Wave Listeners Club, Association of Clandestine Radio Enthusiasts, Association of DX Reporters, Canadian International DX Club, Center for Defense Information, Club Ondes Courtes du Quebec, Richard T. Colgan, Kim Andrew Eliot, European DX Council, Jay Goldberg, Grove Enterprises, Glenn Hauser, International Radio Club of America, Intruder Watch International, William Jahn, Douglas Johnson, Charles Lent, Longwave Club of America, Ed Lyons, Lawrence Magne, Paul Mahe, Jonathan Marks, J. P. Martinez, Ken Mason, Harry Mayo, Miami Valley DX Club, Michigan Area Radio Enthusiasts, Microwave News, Minnesota DX Club, David Morrison, Michael Murray, National Radio Club, North American Short Wave Association, Hihachiro Okamoto, Ontario DX Association, P St. Paperworks, Bob Parnass, Michael Peyton, Popular Communications Magazine, Gene Reich, Review of International Broadcasting, Radio Communications Monitoring Association, Radio Life Magazine, Walter Shepherd, Society to Preserve the Engrossing Enjoyment of DXing, SRI International, Tektronix Corporation, Ken Umberger, Frank Williams, George Wood, World DX Club, and the Worldwide TV-FM DX Association.

The Woodpecker Project Monitoring Team: Carl Albertson (Seattle, WA, USA); P. Beemsterboer (Hoorn, Netherlands); Peter Bentley (East Aurora, NY, USA); John Biro (Chelmsford, MA, USA); James A. Boehm, Jr. (San Antonio, TX, USA); Charles Bolland (Lakeworth, FL, USA); Michael E. Boschat (Halifax, NS, Canada); Kenneth W. Bowles (Union, MO, USA); Dustin Brann (Kansas City, MO, USA); L. Burkhardt (Los Alamos, NM, USA); Mike Chinakos (Camas, WA, USA); Robert Cohen (Natal, South Africa); James A. Conrad (Waterloo, IA, USA); Frank B. Cook (Seattle, WA, USA); Ron K. Cross (Somerset, England); Martin W. Croze (Edina, MN, USA); Vladimir Cucura, Jr. (Reading, PA, USA); Allan I. Cummings (London, England); Gerry L. Dexter (Lake Geneva, WI, USA); Bjorn Otto Donnum (Dal, Norway); William E. Ellenback (Lake Helen, FL, USA); Jerry Ervine (Hidalgo, TX, USA); Tom Fleres (Fontana, WI, USA); Sholom Gliksman (Chicago, IL, USA); Jay Goldberg (Bethesda, MD); Robert P. Gundersen (Northfield, MN); Geoff Halligey (N. Humberside, England); Dave Hammer (Columbus, OH, USA); Michael Harla (Philadelphia, PA, USA); John P. Harrison (Santa Fe, NM, USA); Greg Hart (Live Oak, FL, USA); Wieland Hartwig (Tokoroa, New Zealand); Robin L. Harwood (Tasmania, Australia); George Heresco (Hay River, NWT, Canada); Philip Hodgson (Stamford, England); Michael Hudson (Canterbury, England); Carl Huffaker (Mexico City, Mexico); James Kamoie (Altoona, PA, USA); Chris A. Kantack (Roseburg, OR, USA); Hidemitsu Katsura (Chigasaki City, Japan); Tom Kephart (Mt. Pleasant, MI, USA); Helmut Klein (Vienna, Austria); Robert Knowles (Tuakau, New Zealand); Arnold J. Lausevich (Milwaukee, WI, USA); Fred Lehman Cincinnati, OH, USA); Fred Lehmann (Sioux Falls, SD, USA); Paul Lerner (East Meadow, NY, USA); Derek Lynch (Mullingar,

Ireland); Paul Mahe (Laroche Derrien, France); Peter Manson (Glasgow, Scotland); Bill Martin (Hornsby Heights, Australia); Stanley D. Mayo (Yarmouth, ME, USA); Denis McCauley (Ile Takapoto, Fr. Polynesia); Ken McCulloch (The Pas, Manitoba, Canada); Patrick McDonald (Dural, NSW, Australia); Carlos McEvilly (Petaluma, CA, USA); David S. McNally (McAllen, TX, USA); James J. McNeal (Austin, TX); A. C. Molloy (Merseyside, England); Don Moman (Edmonton, Alberta, Canada); Eugene Munger, Jr. (Montgomery, AL); Dennis W. Murphy (Orlando, CA, USA); Amane Nakamura (Tokyo, Japan); Frank Nathanson (Staten Island, NY, USA); Robinson Navamanie (Colombo, Sri Lanka); Derrick Dickson Norville (Port of Spain, Trinidad); Sei Ohmi (Anjo-Shi, Japan); Lars Erik Olsson (Kiruna, Sweden); Frank F. Orcutt (Alameda, CA); G. Tom Pailloz (Huntsville, AL, USA); Nigel Pimblett (Medicine Hat, AB, Canada); William G. Preston (Rheem Valley, CA); John T. Reed (Ponca City OK, USA); Ken Reiss (Manchester, MO, USA); Lawrence J. Rempala (Pompano Beach, FL, USA); Kurt Ringel (Wiesbaden, FRG); Michel Rochon (Fredericton, NB, Canada); Jim Rosenbluth (Washington, DC, USA); Nestor Rubio (Mar del Plata, Argentina); Duleep Sahadevan (Calicut, India); Andre Schmidt (Taunusstein, FRG); Jerry F. Schmidt (Eau Claire, WI, USA); Gary Shaw (Lexington, KY, USA); Walter E. Shepherd (Chatsworth, CA, USA); Harry Skoutajan (Grobenzell, FRG); Steven Smith (South Lincs., England); Ed Southwell (Basingstoke, England); William Spragg (St. John West, NB, Canada); Lubomir Stejskal (Nejdek, Czechoslovakia); Keith Sunday (Ft. Worth, TX, USA); Dennis Sylte (Manassas Park, VA, USA); Abhilash Thadani (Ahmedabad, India); Bruce Tindall (Chapel Hill, NC, USA); Toshiki Tsurumi (Bisai City, Japan); Robert E. Vetter (Van Nuys, CA, USA); Mike Walker (Indianapolis, IN, USA); J. M. Waters (Orangevale, CA, USA); Robert Weller (San Francisco, CA, USA); Frederick White (Old St. Augustine, FL, USA); Jerry Winder (Houma, LA, USA); Jeffrey C. Wrolstad (Madison, WI, USA); Dan Yemiola (Cincinnati, OH, USA); Steve Ziegler (S. Portland, ME, USA)

10 November 1977

Appendix:

I.F.R.B. REPORT ON HARMFUL INTERFERENCE IN THE HIGH FREQUENCY BANDS CAUSED BY EMISSIONS ORIGINATING IN THE U.S.S.R.

Introduction

1. This Report, prepared by the I.F.R.B. in accordance with Section VII of Article 9 of the Radio Regulations and in particular No. 628, relates to harmful interference caused to various services of many Administrations by a station or stations carrying out tests in the HF bands.

2. According to reports from Administrations, Fixed, Aeronautical Mobile, Maritime Mobile, Broadcasting and Amateur Services operating in accordance with the provisions of the Radio Regulations on frequencies between 4 and 23 MHz have suffered severe harmful interference on frequent occasions from pulse transmissions emanating from a station or stations in the U.S.S.R. from September 1976 to the present time.

3. A history of the correspondence exchanged and the action taken since the Board received the first information on this subject appears in the attached Annex. It may be summarized as follows:

- the first period (from 3 September 1976 to 17 December 1976) when complaints of interference received by the Board were treated in accordance with Article 15 of the Radio Regulations, following which the Board received a communication from the U.S.S.R. that "... the necessary measures are being taken to reduce any such interference ...";
- the second period (from 23 December 1976 to 5 July 1977) during which further complaints established that the interference persisted and following further action by the Board, a letter was received from the U.S.S.R. again stating that steps were being taken to eliminate possible interference;

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- the third period (from 17 August 1977 to the date of this Report) when it became clear that despite repeated interventions, which resulted in a communication being received from the U.S.S.R. that action would be taken to alleviate the interference, it still persisted and, in view of the requests from certain Administrations referring to Section VII of Article 9, the Board proceeded with the present Report.

Harmful Interference Procedure

4. The role of the I.F.R.B. in resolving cases of harmful interference is normally carried out in accordance with Article 35 of the Convention and Article 15 of the Radio Regulations, and is generally restricted to the provisions of those articles. This leads to recommendations of a regulatory, technical and/or operational nature which can be effected only through the cooperation and goodwill of the Administrations concerned. There are provisions both in the Convention and in the Radio Regulations which state that Administrations shall not establish and operate stations that are capable of contravening the Regulations and which result in harmful interference to the radio services of other Administrations operating in accordance with the Radio Regulations and if any such interference is caused it shall be eliminated.

5. When the Board is called upon to intervene in a case of harmful interference it can only act within the framework of the Convention and the Radio Regulations. In ordinary cases of harmful interference the procedure is set forth in Article 15 but the action now being taken by the Board in this exceptional case is in accordance with the provisions of Section VII of Article 9 of the Radio Regulations.

6. This case of interference is exceptional insofar as the wide-band emissions in the first instance are reported at various frequencies over an extremely wide range of the high frequency spectrum and no notifications have been made to the I.F.R.B. The reports concerning the emissions although conclusive in the fact that interference is being caused are inconclusive in respect of the completeness of the characteristics of the emissions. The Administration responsible for the emissions having chosen not to apply the Regulations dealing with the notification and recording of frequencies, nor any other provisions of the Radio Regulations concerning these emissions, creates certain voids in the normal procedure and recommendations in dealing with cases of harmful interference.

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7. This case is extraordinary also in the sense that it has caused interference to all of the services operating in the bands where the emissions occur and in particular, according to the reports received by the Board, extensive interference has been caused to services such as the Maritime and Aeronautical Mobile Services where safety of life is of vital concern. In addition the services of many Administrations have been affected and despite the efforts of the Board to deal with the case under Article 15 little or no change has taken place in the intensity and frequency of the harmful interference being caused. Therefore, due to the extraordinary nature of the case it has not been possible to deal with it successfully through the normal procedures. It is difficult for the Board to make any ordinary recommendations such as those which would be made in a normal case of interference. It is also difficult, in view of the lack of provisions to deal with such cases, to include in the report any positive immediate steps that would eliminate the interference.

Characteristics of the interfering emission

8. The monitoring work that Administrations undertook to assist in identifying the interfering emissions together with the monitoring results that were received with the complaints of interference generally indicate that the characteristics of the interfering emission are as follows:

a) Nature of emission

All monitoring reports show that the interfering emissions are pulse emissions comprising groups of pulses with a repetition rate of 10 Hz.

b) Occupied bandwidth

Some reports indicate that the emissions spread over a bandwidth of a few hundred kHz to more than one MHz. One report shows that the basic emission lies within a bandwidth of some 16 - 18 kHz (containing 70 - 80% of the total power) accompanied by a large number of sidebands spaced symmetrically at 10 kHz intervals on each side.

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c) Frequency bands concerned

The interfering emission appears irregularly in different frequency bands between 4 and 23 MHz but the majority of monitoring observations report the interference between 8 and 17 MHz.

d) Field strength of the interference

One Administration reports the field strength of the interference as between 40 – 60 dB above 1 μV/m as measured in the basic bandwidth of the emission (i.e. 15 kHz approximately). It also reports that stations of the Fixed and Broadcasting Services operating on frequencies in the sidebands of the interfering emission are not affected; other services such as the Maritime, Aeronautical and Amateur Services, however, suffer more or total interference.

e) Hours of operation

The monitoring reports indicate that there is no regularity in the time or duration of the emissions; they can last from several minutes to several hours.

f) Origin of interfering emissions

All monitoring reports place the source or sources of the interfering emissions within the territory of the U.S.S.R. (The U.S.S.R. Administration has acknowledged that tests are being carried out in the HF bands in the Soviet Union and that these tests may cause interference, see paragraph 4 of the attached Annex).

Conclusions and Recommendations

9. There is no doubt that for more than a year pulse emissions in the HF bands emanating from the U.S.S.R. have caused widespread harmful interference to the various services of other Administrations which are using frequencies in the same bands in conformity with the Radio Regulations.

10. The U.S.S.R. have stated that the interfering emissions are for test purposes in which case No. 709, Section IV of Article 14 of the Radio Regulations applies. This regulation provides that "... Any harmful interference resulting from tests and experiments shall be eliminated with the least possible delay". The finding of

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the Board is that the station or stations in question should cease operation until such steps have been taken to ensure that any interference that may result from the resumption of such tests shall be below the level that would be considered as harmful interference. To this end the Board recommends that among the steps to be taken are the following:

a) No emissions shall be made in any of the frequency bands where the safety of life and property may be at risk: namely, in the bands allocated exclusively to the Maritime Mobile Service and the Aeronautical Mobile Service.

b) The radiated power of any emission shall be reduced to the minimum necessary for the purposes of the tests.

c) Measures shall be taken to reduce the out-of-band radiated power (that is the power radiated outside of the minimum necessarily occupied bandwidth of the basic emission) to the maximum possible extent by appropriate filters or other means.

d) Emissions shall not take place on frequencies close to the bands allocated to the Mobile Services mentioned above to avoid any residual sideband energy falling in these bands.

e) A programme of daily or weekly emissions might be co-ordinated with the Administrations concerned.

11. The Board will consider any comments received in accordance with No. 634 of the Radio Regulations and it would welcome any information on technical means which might permit the Board to make further recommendations within the provisions of the Convention and the Radio Regulations to help towards a solution of this problem.

Annex: Historical account

Adopted by the I.F.R.B. at its 1334th Meeting on 10 November 1977

ANNEX to the

I.F.R.B. REPORT ON HARMFUL INTERFERENCE IN THE HIGH FREQUENCY BANDS CAUSED BY EMISSIONS ORIGINATING IN THE U.S.S.R.

HISTORICAL ACCOUNT

1. By telex of 3 September 1976 the Administration of Denmark sent the I.F.R.B. the text of a message addressed to the Administration of the U.S.S.R. (by Denmark), giving, among other things, the characteristics of interference they were experiencing. At the same time, the Administration of Denmark requested the I.F.R.B. to inform it whether it was in a position to give assistance in identifying the interfering station in order to eliminate the interference.

2. On 17 September the Board sent a letter to the following Administrations asking them to carry out a monitoring programme in order to identify the source of interference: Federal Republic of Germany, Sweden, Belgium, France, Norway and Austria.

3. On 25 October 1976 the Board sent a telex to the Administration of the U.S.S.R. asking it to take the necessary measures to eliminate the interference. This action of the Board followed a request for assistance received from the Administrations of Switzerland (4.10.1976), Norway (5.10.1976) and Sweden (18.10.1976) in accordance with Article 15 of the Radio Regulations. During the same period the Board received, for information, copies of messages addressed to the U.S.S.R. Administration by the Administrations of Denmark (22.9.1976) and the United Kingdom (13.10.1976). In its message of 7.10.1976 the Administration of the U.S.A. requested the assistance of the I.F.R.B. in accordance with No. 627 of the Radio Regulations.

4. On 3 December 1976 the Administration of the U.S.S.R. sent the following message to the I.F.R.B.: "In the Soviet Union tests are being carried out with radio installations operating in the HF bands. These tests may cause interference to radio installations for short periods. The necessary measures are being taken to reduce any such interference. The reports which you have sent us will be carefully studied." The Administration of the U.S.S.R. sent a similar message on 17 December 1976 to the Administrations of Norway, Denmark, U.S.A., Canada, the United Kingdom, France, Sweden, the Federal Republic of Germany, Portugal, Austria and Italy.

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5. During the period from 23 December 1976 to 6 April 1977 the Board received, for information, copies of messages sent to the Administration of the U.S.S.R. by the Administrations of Denmark (23.12.1976 and 22.2.1977), France (23.12.1976 and 28.2.1977), Norway (29.12.1976 and 12.5.1977), the United Kingdom (3.3.1977), Sweden (6.3.1977) and the Federal Republic of Germany (6.4.1977). These messages were sent to the Administration of the U.S.S.R. with a request that it take steps to stop the interference. During the same period the Board received a message from the Administration of the U.S.A. (28.2.1977) stating that they were still experiencing interference.

6. The Board, being informed that the interference was still being experienced, sent a letter to the Administration of the U.S.S.R. on 10 May 1977, requesting information concerning the measures being taken to eliminate the interference.

7. The Board received the following reply from the Administration of the U.S.S.R. on 5 July 1977:

> "In reply to your letter IFRB 18/735/0.3502/77 of 10 May 1977, the U.S.S.R. Administration would inform you that in the Soviet Union the investigation of HF radio stations is continuing. Steps are being taken to eliminate possible interference with the radio services of other countries' telecommunication administrations. The effectiveness of the measures adopted is confirmed by data collected by the monitoring services. Further action aimed at the prevention of interference is scheduled."

8. Following the above, the Board received copies of messages sent to the Administration of the U.S.S.R. by the Administrations of France (17.8.1977), Denmark (22.9.1977), Sweden (26.8.1977) and Norway (30.9.1977). These messages stated that the interference was still being experienced. In their messages, the Administrations of Denmark and Sweden added "we ask the I.F.R.B. to pay serious attention to this matter and to continue its representations towards the Administration of the U.S.S.R. to make every effort to bring this interference to an end".

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9. The Board sent a telex to the Administration of the U.S.S.R. on 30 August 1977 requesting it to take the necessary measures to eliminate the interference affecting assignments which had the right of international protection and/or which had obtained international recognition.

10. The Administration of Norway sent the I.F.R.B. a copy of a message (30 August 1977) addressed to the Administration of the U.S.S.R., to which had been added the following text: "this Administration is not satisfied with the action which to our knowledge has been taken by the I.F.R.B. in this matter. We therefore kindly ask the Board to make any effort to bring this serious harmful interference to an immediate end". In a short letter (3 October 1977) the Administration of the Federal Republic of Germany requested the I.F.R.B. "to proceed according to the provisions laid down in the Radio Regulations".

11. The Board sent a telex to the Administration of the U.S.S.R. on 4 October 1977 with copies to the Administrations concerned informing them that I.F.R.B. action taken up to that time had been in conformity with the provisions of Article 15 of the Radio Regulations and that the Board was awaiting a reply to its telex of 30 August 1977 from the Administration of the U.S.S.R.; however, in view of the telexes received from the Administrations of Norway and the Federal Republic of Germany, the Board would proceed to a review of the case in accordance with No. 628 of the Radio Regulations.

12. On 17 October a further telegram was received from the Administration of France stating that the interference still exists and further requesting the Board to seek a satisfactory solution to the problem.

13. To the date of this Report no reply has been received from the Administration of the U.S.S.R. by the Board in response to its telex of 4 October 1977.